(Systems) Girders.

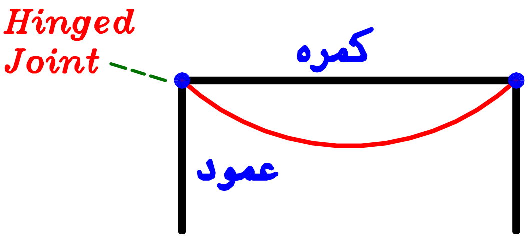
نسألكم الدعاء

IF you download the Free **APP.** RC Structures YASSER EL LEATHY on your smart phone or tablet, you will be able to play illustrative movies For any paragraph that has a QR code icon

اذا حملت تطبيق RC Structures YASSER EL LEATHY على تليفونك المحمول او اللوح السطحى ستستطيع أن تشغل أفلام شرح للمقاطع التى تحتوى على رمز

Girders. Table of Contents.

Connection between Beam & Column.



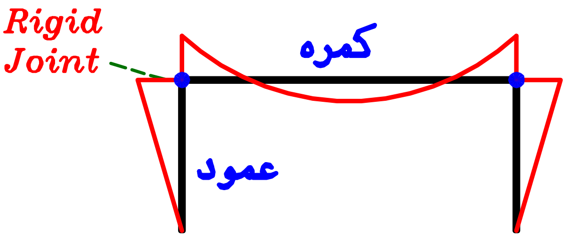
يكون ال **B.M.** من الاحمال الموجوده على الكمره

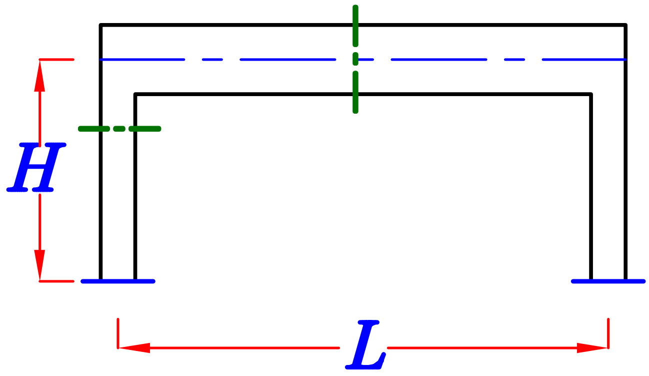
أى أنه دائما الكمره عليها **B.M.**

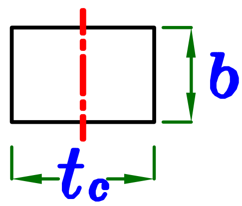
ولكن وجود **B.M.** على العمود يعتمد على ال ***Joint***

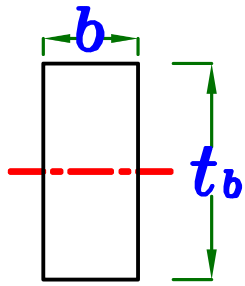
بين الكمره و العمود اذا كانت ***Hinged or Rigid***

و ذلك يعتمد على ال ***Stiffness*** بين كلا من الكمره و العمود







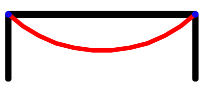


$$I_c = \frac{b\, t_c^3}{12} \qquad I_b = \frac{b\, t_b^3}{12}$$

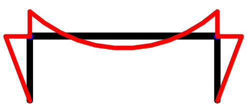
$$\boxed{K_b = \frac{E\, I_b}{L}} \qquad \boxed{K_c = \frac{E\, I_c}{H}}$$

Relative Stiffness.

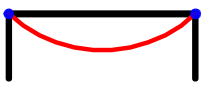
$$\boxed{K_r = \frac{K_b}{K_c}}$$



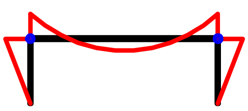
اذا كانت قيمه K_r كبيره نسبيا تعتبر ال *Joint* بين الكمره و العمود *Hinged*



اذا كانت قيمه K_r صغيره نسبيا تعتبر ال *Joint* بين الكمره و العمود *Rigid*

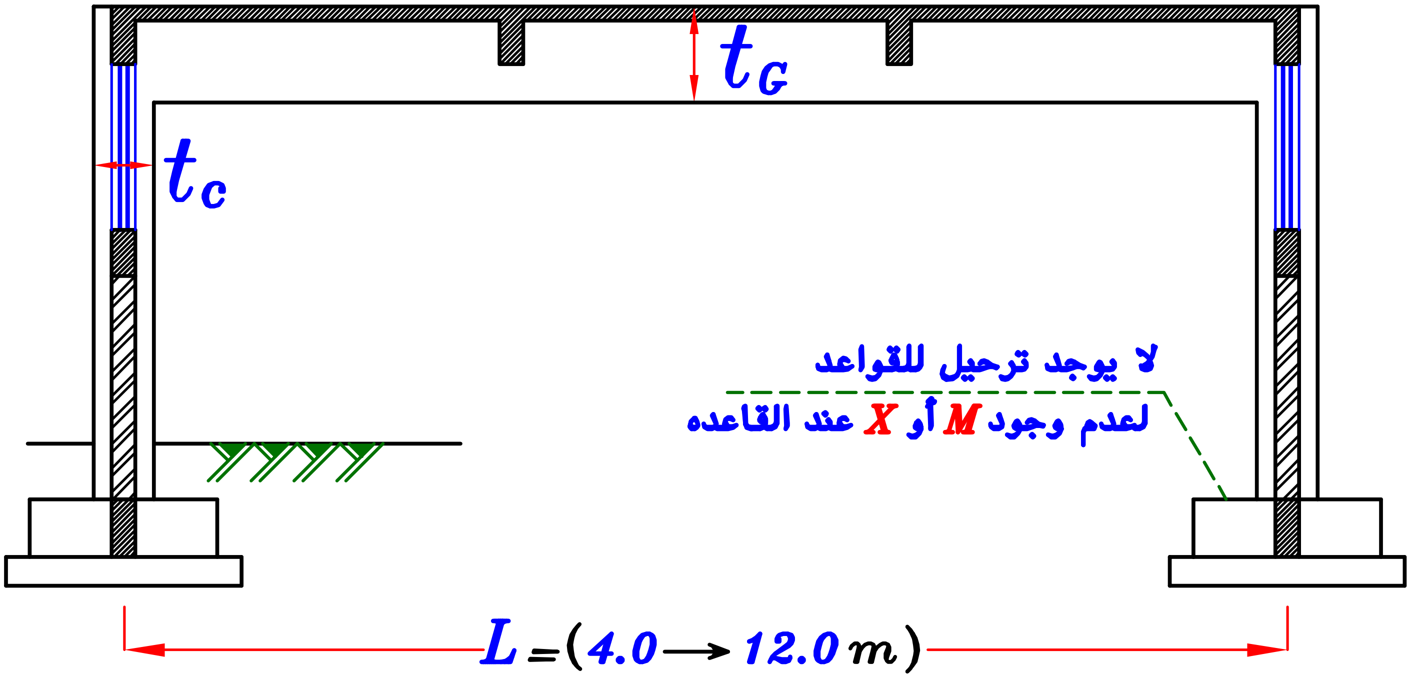


للتسهيل سنعتبر أنه عندما تكون $t_c \leq \frac{t_b}{2}$ تكون ***Hinged Joint***



و عندما تكون $t_c \geq 0.8\, t_b$ تكون ***Rigid Joint***

Girder's Concrete Dimensions.



Simple Girder $\longrightarrow$ For all types of soil.

Continuous Girder $\longrightarrow$ For medium and hard soil.

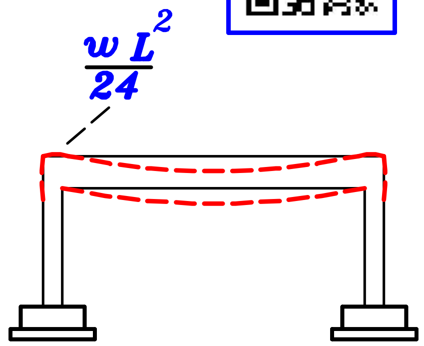
Concrete Dimensions.

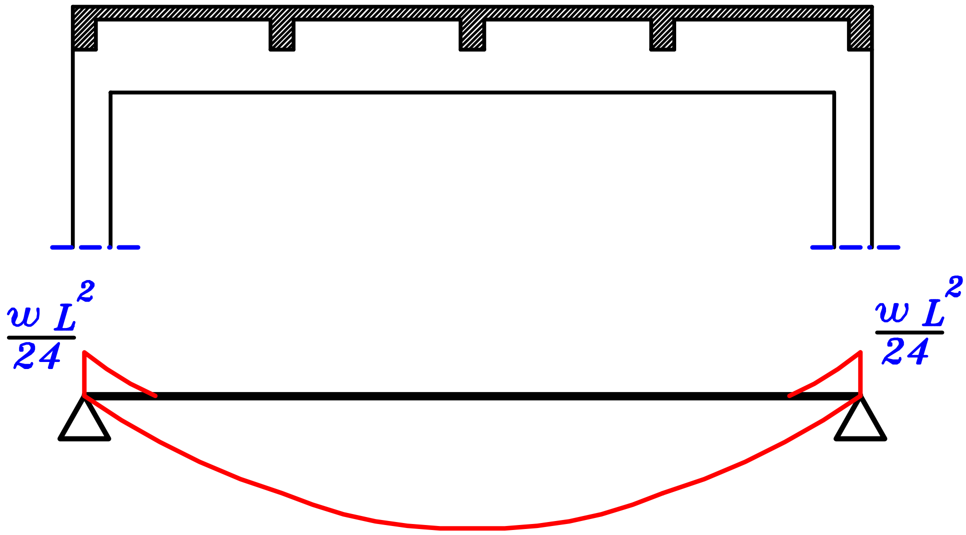
* Span of girders $(L) = (4.0 \longrightarrow 12.0)$ m.
  يفضل عمليا (L) حتى ١٠م و ممكن أن يصل الى ١٢م.

* $t_G = \frac{L}{10}$ Simple
  $\frac{L}{12}$ Continuous
  $\frac{L_c}{5}$ Cantilever

* $t_c \leqslant t_G \qquad (t_c \simeq 0.7 \rightarrow 0.9\ t_G)$

* $b = \left.\begin{array}{l} 0.30\ m \\ \frac{Spacing}{20} \end{array}\right\}$ الأكبر





نعتبر أن الـ **Connection** بين الكمره و العمود عباره عن **hinged support**

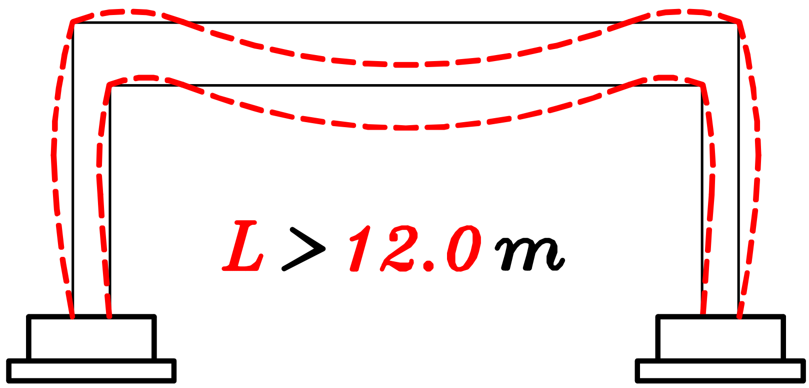
و ذلك لان $t_c \leqslant t_G$ أى أننا أهملنا الـ **Frame action** بين الكمره و العمود .

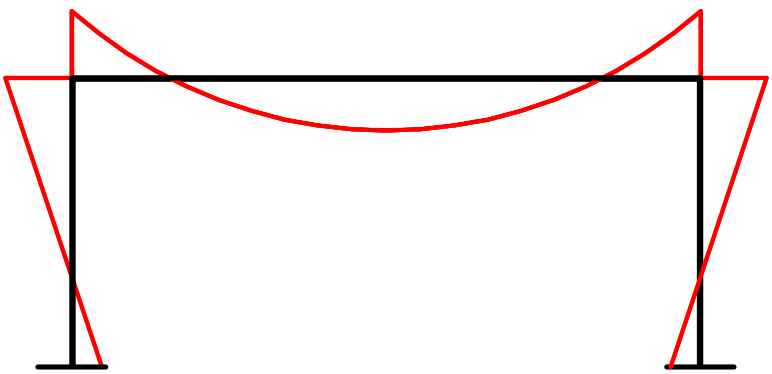
ينتقل فقط عزم $\frac{w\,L^2}{24}$ من الكمره الى العمود و نهمله عند تصميم العمود .

إذا زادت الـ **Span** عن ١٢,- م يتحول الى **Frame**

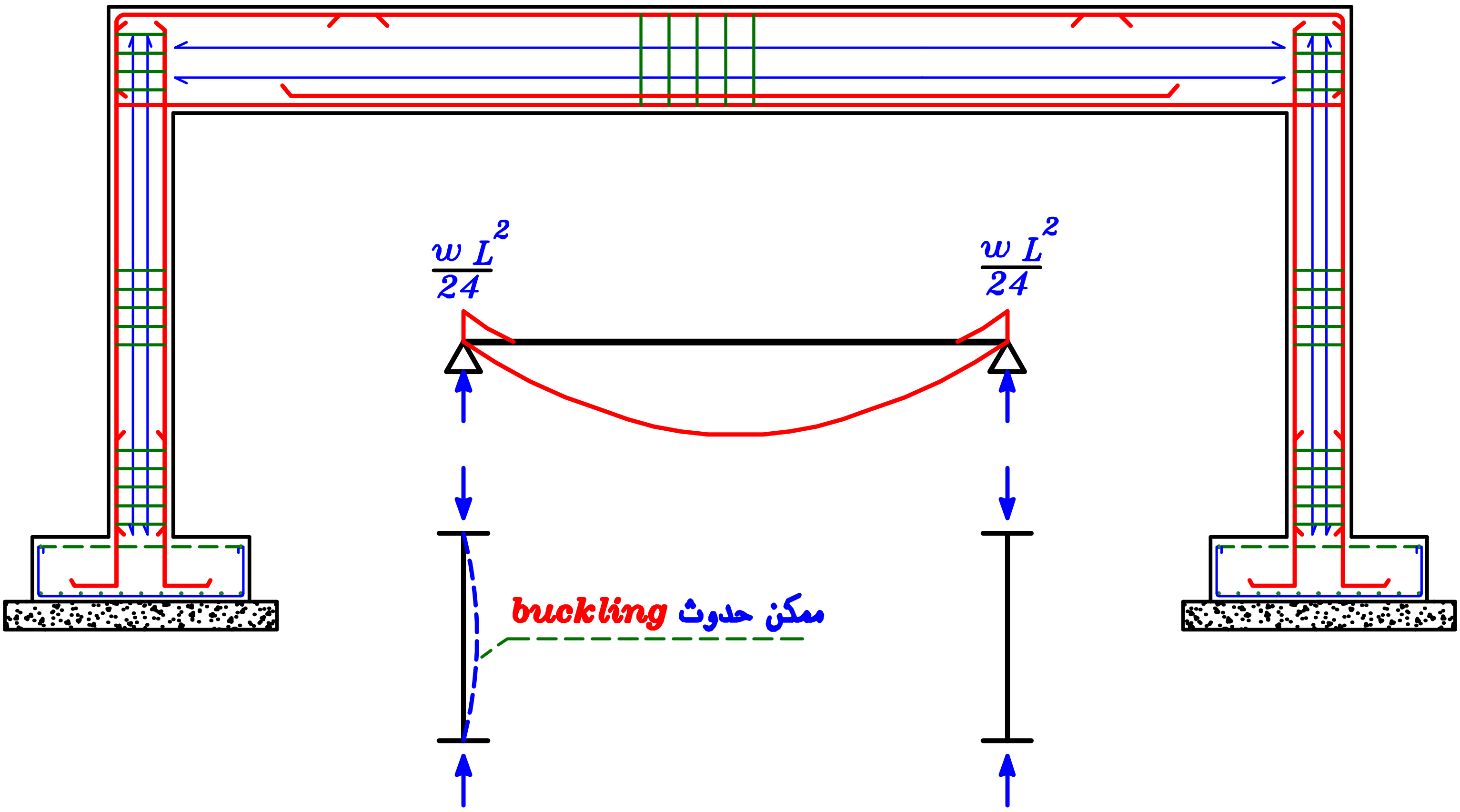
لأننا لن نستطيع إهمال الـ **Frame action** بين الكمره و العمود

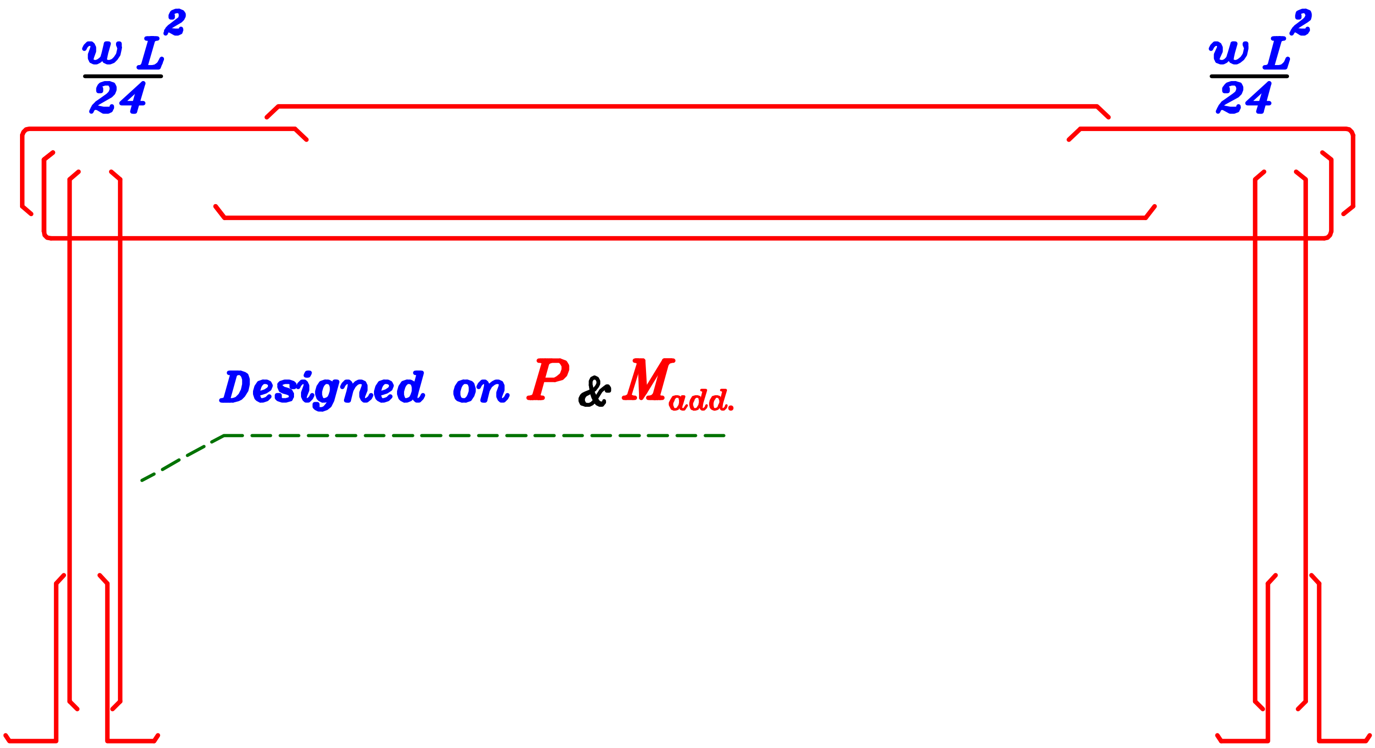
حتى إذا كانت $t_c \leqslant t_G$



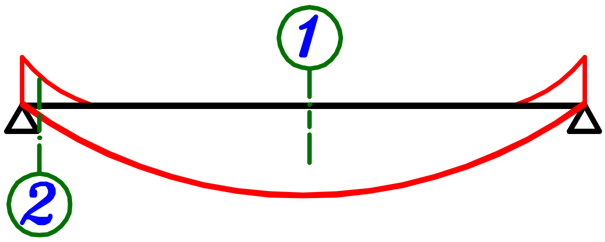


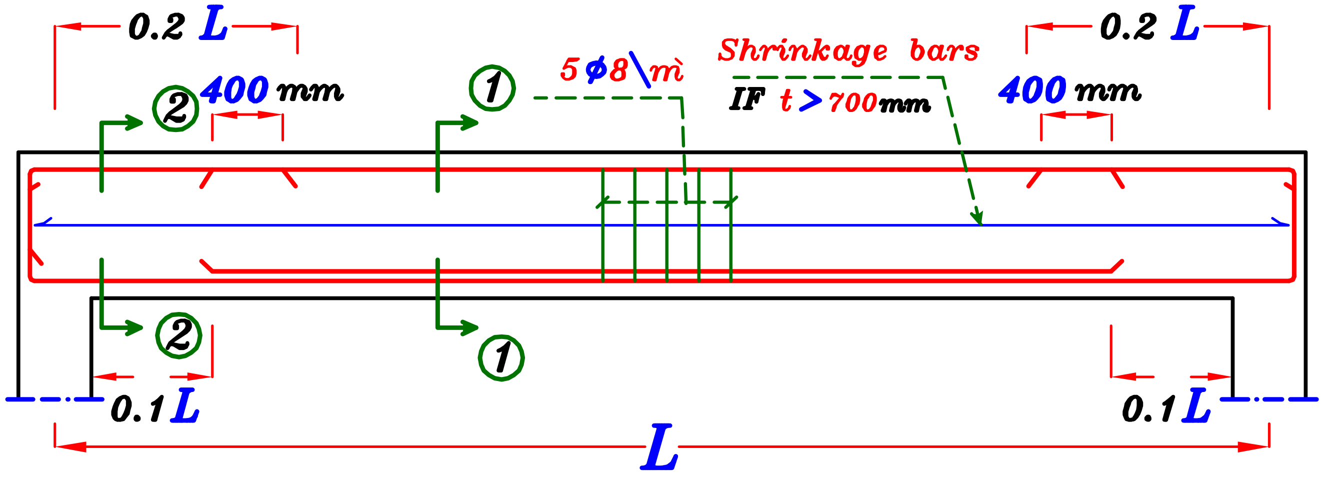
RFT. of Girders.

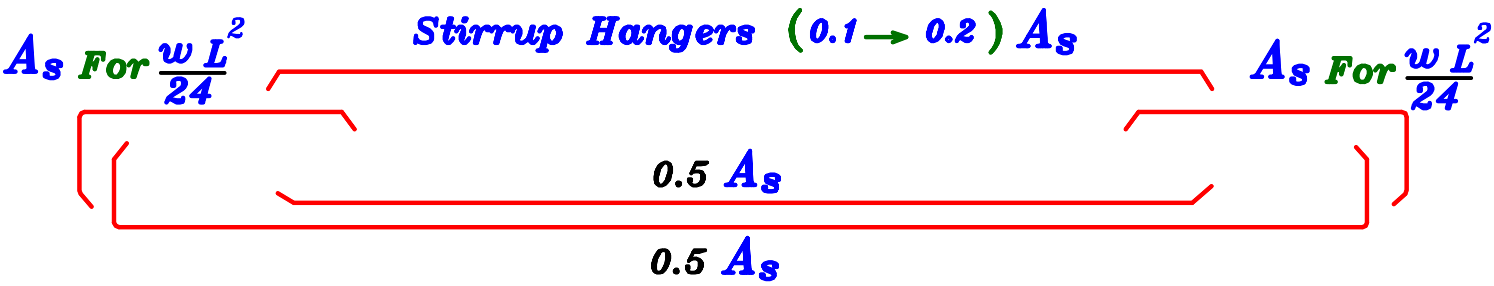


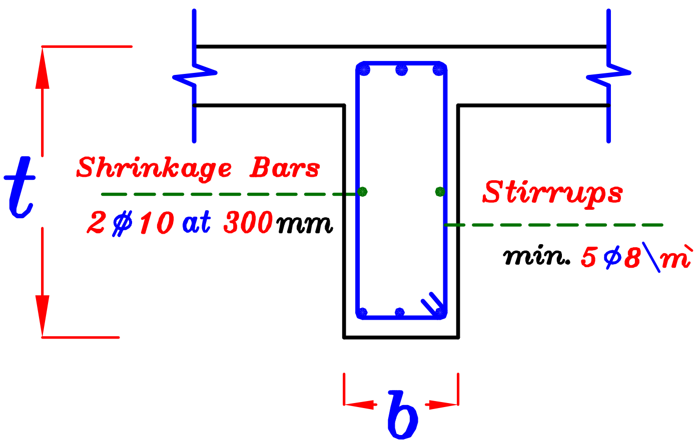


Simple Beam.

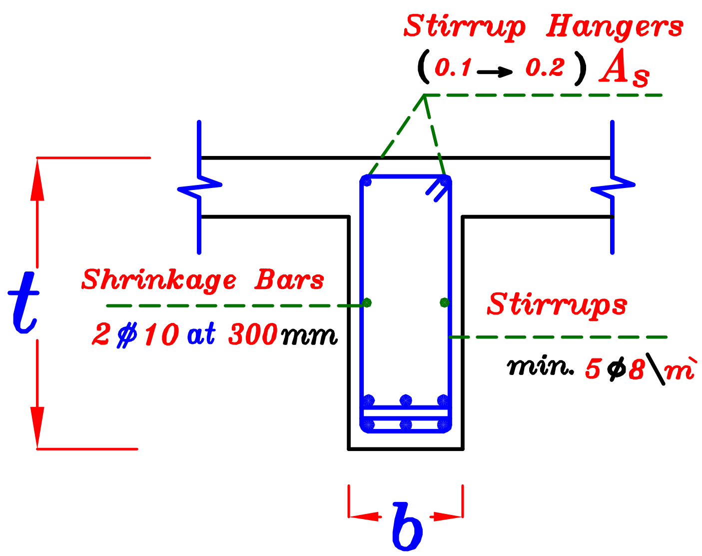






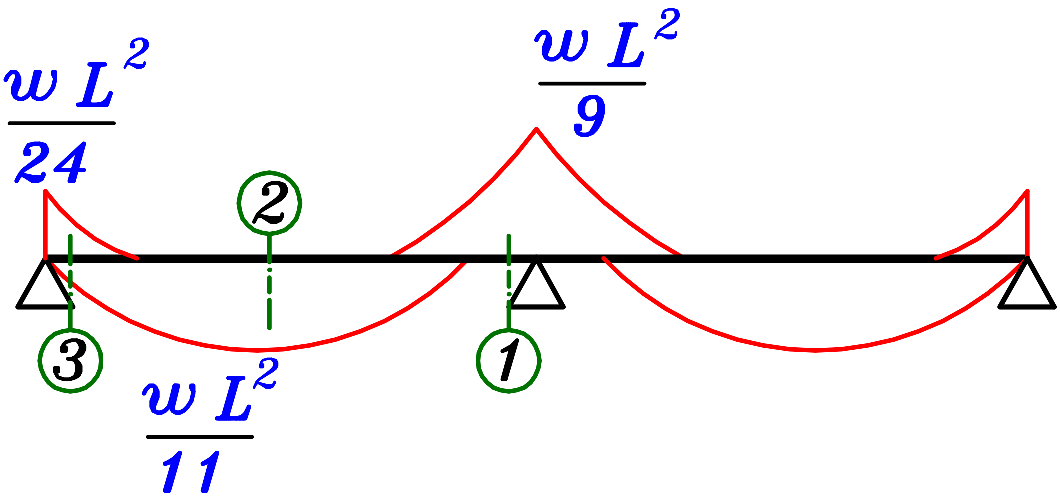


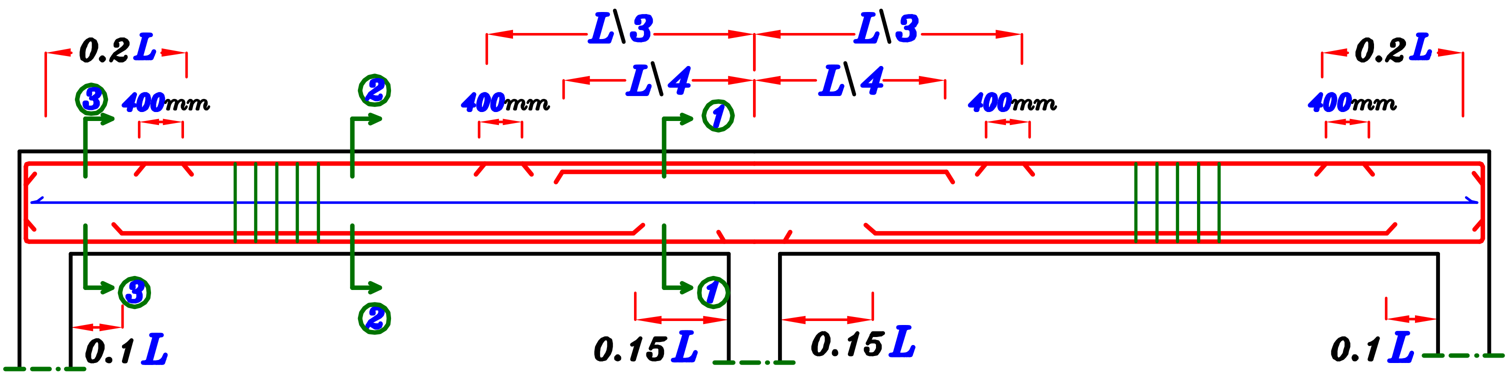
Sec. (2–2)

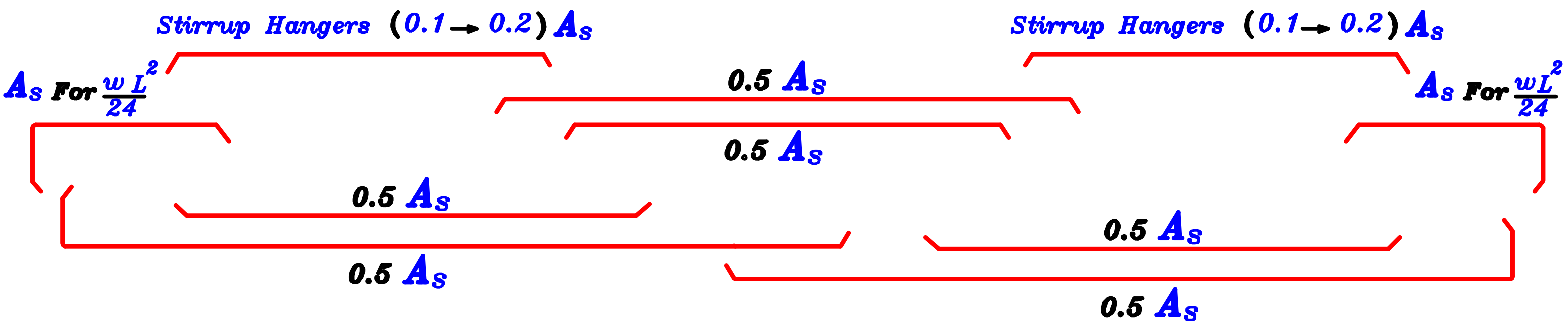


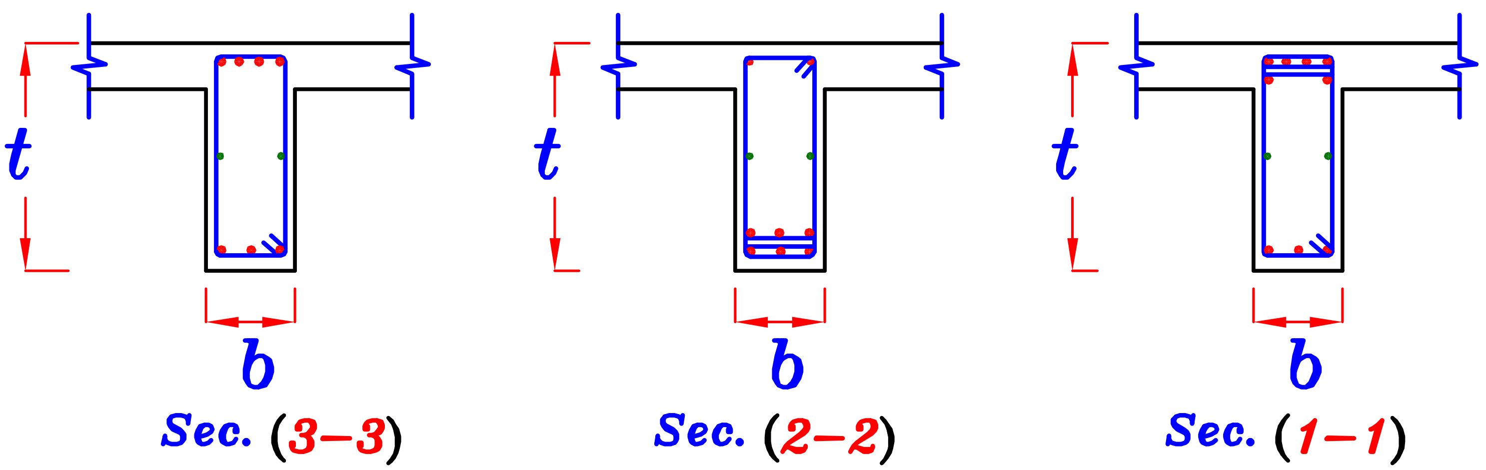
Sec. (1–1)

Continuous Girder Two spans.

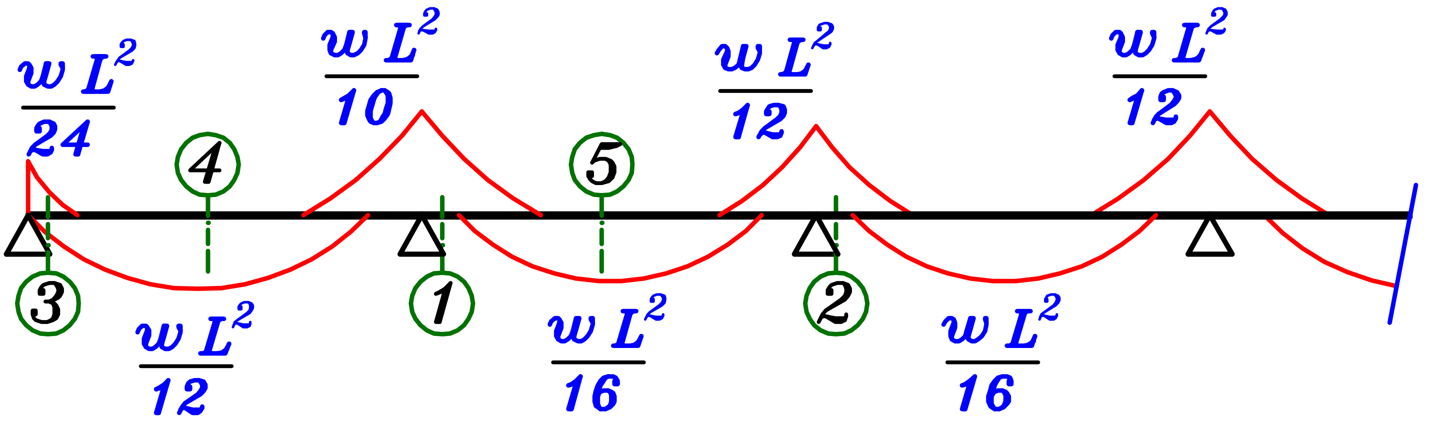


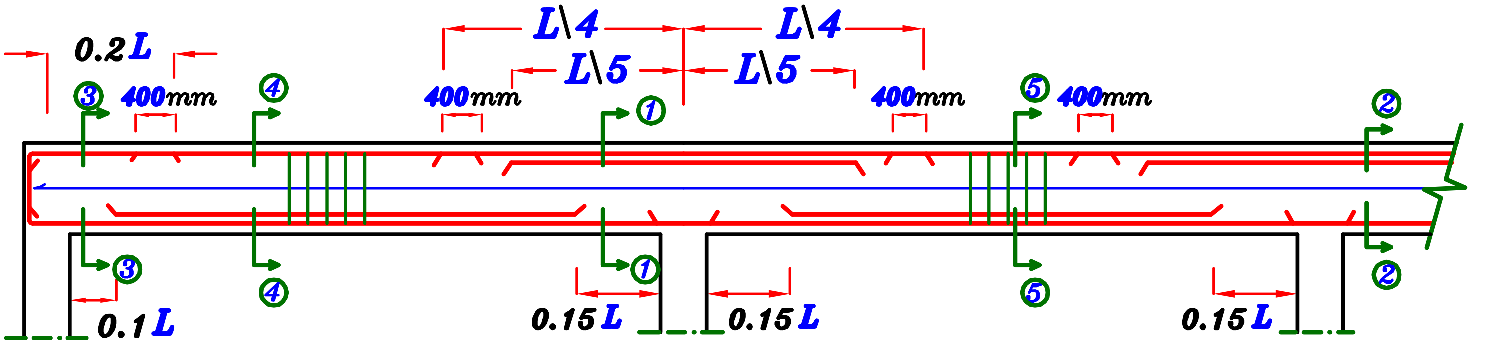


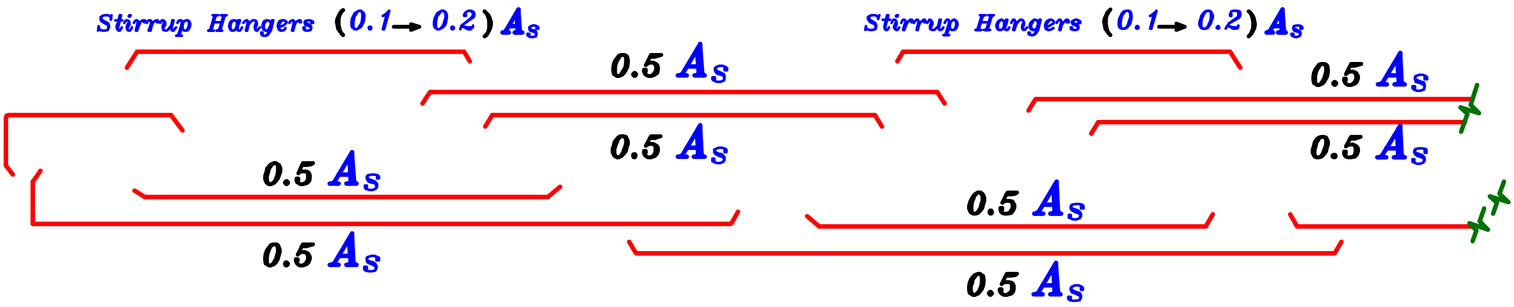


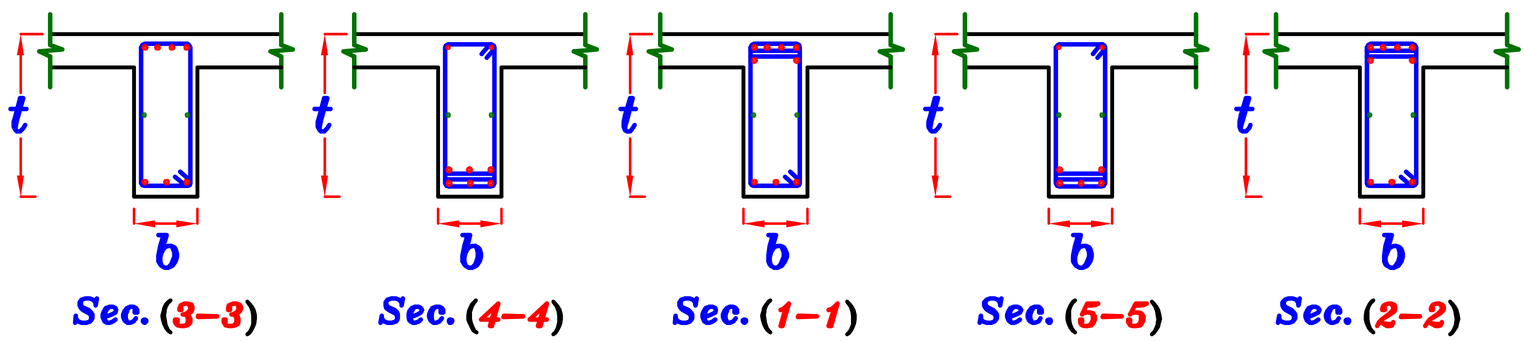


Continuous Girder More than 2 Spans.

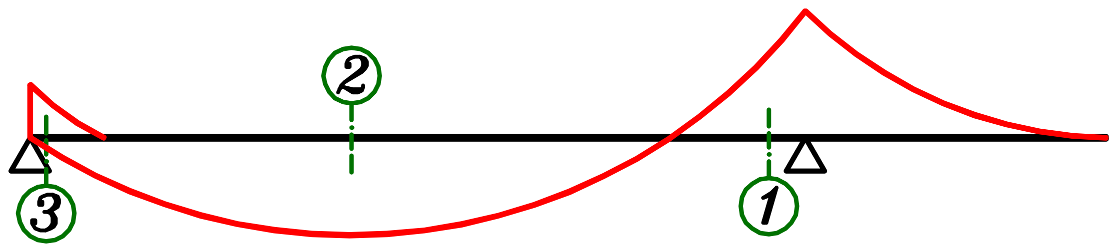


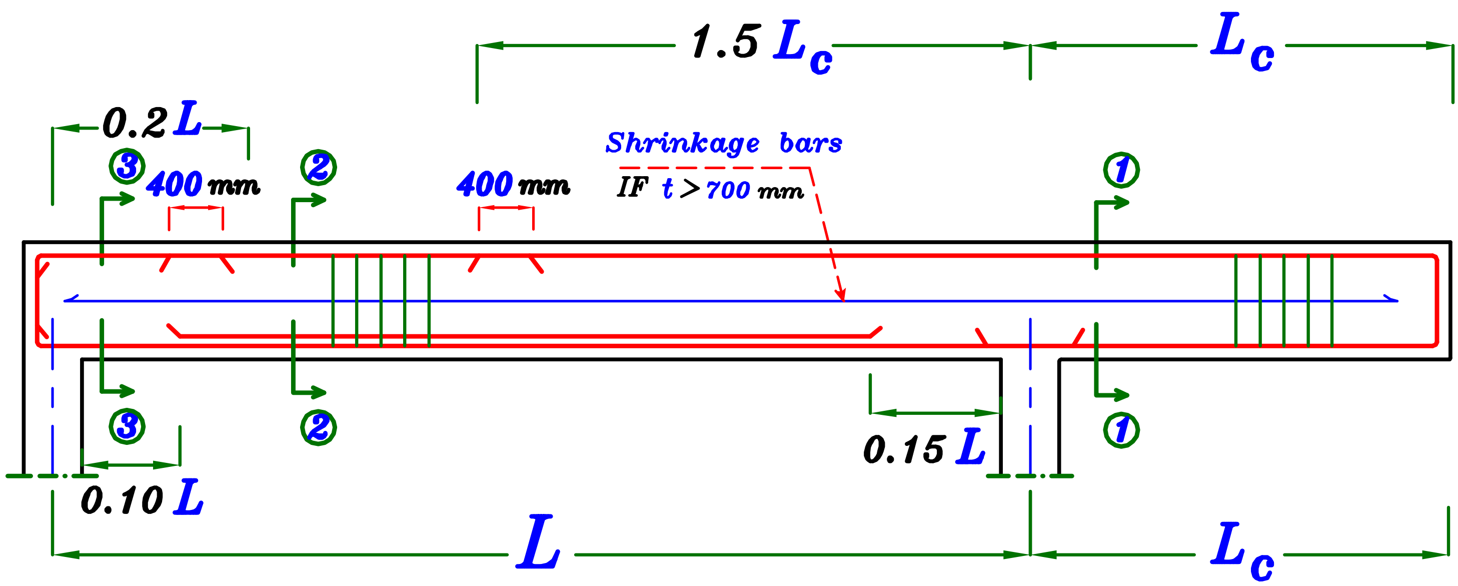


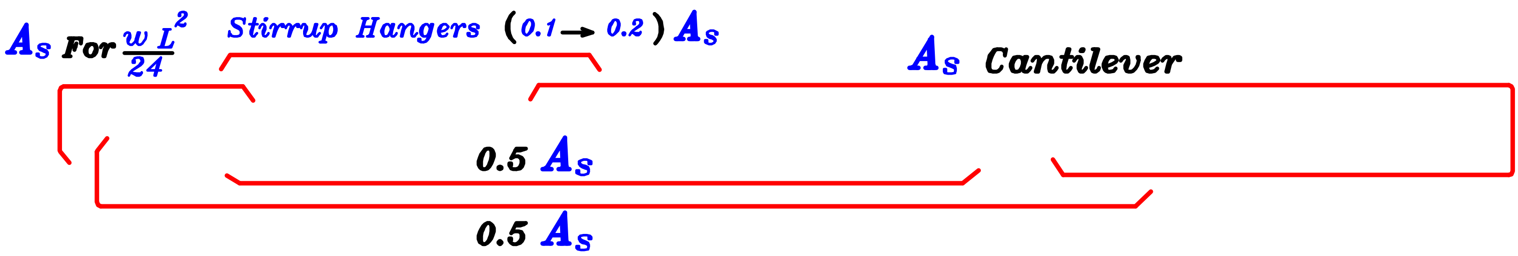


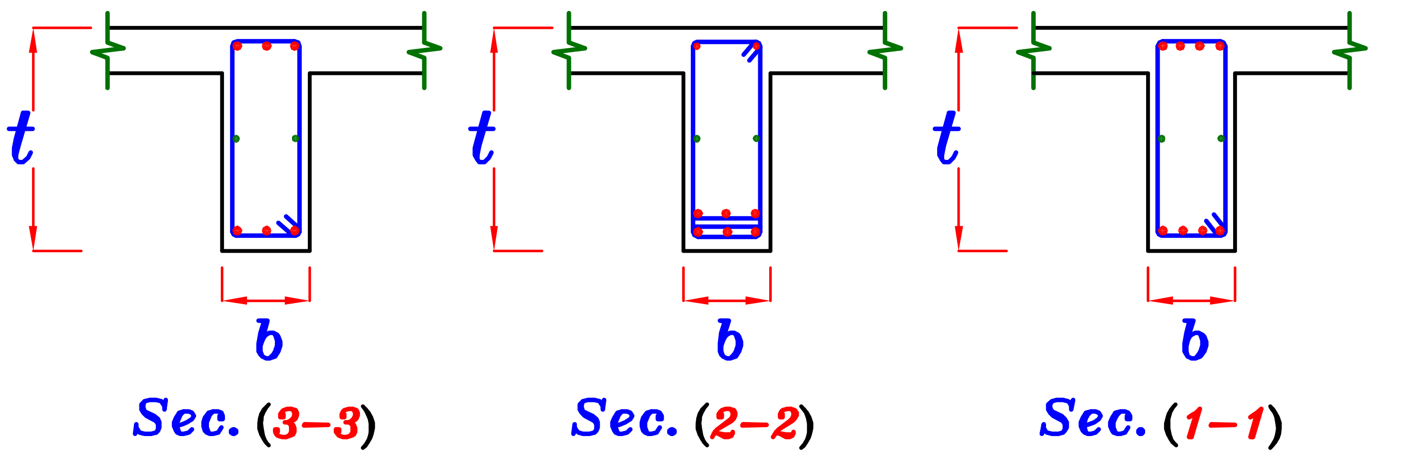


Beam with Cantilever.







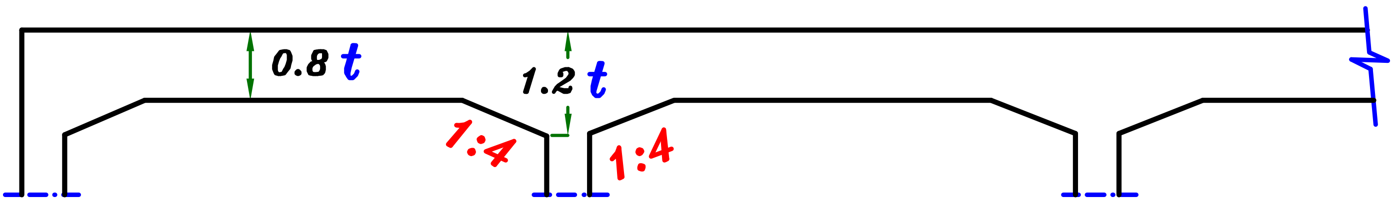


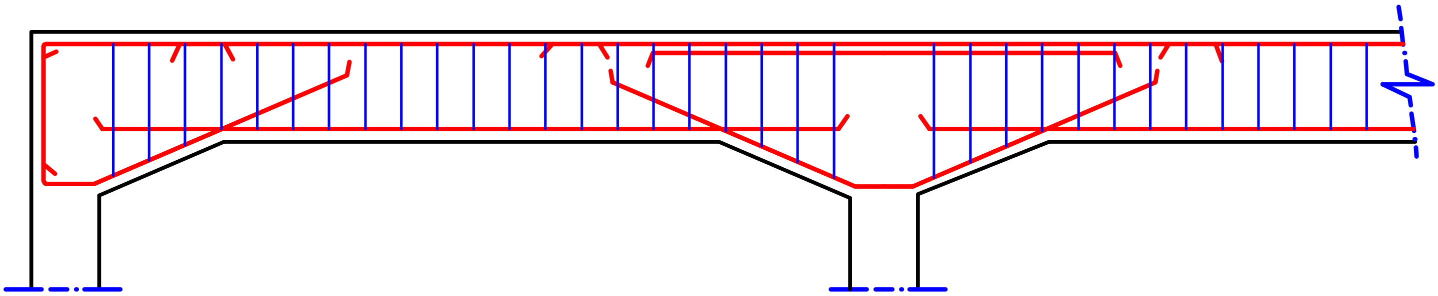
Girder with variable depth.

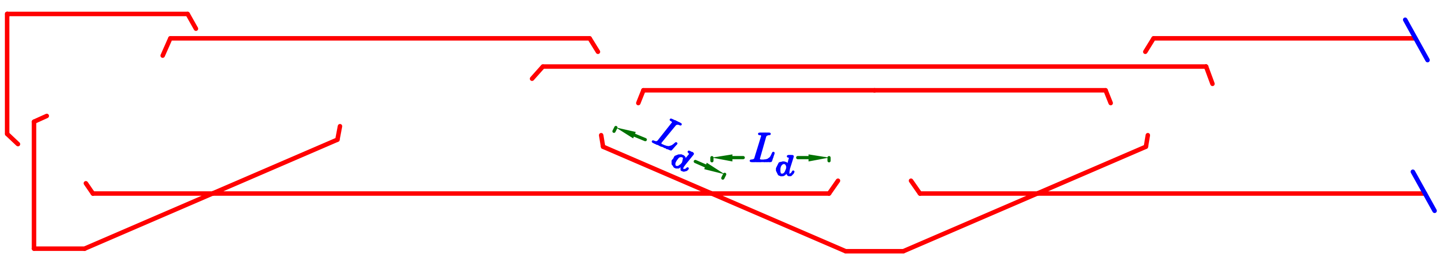
ممكن عمل *Variable depth* للكمره لزياده *clear height* فى منتصف الكمره .

او لزياده مقاومه الـ *Shear* اذا كان كبير .

$$\boxed{t \simeq \frac{L}{12}}$$







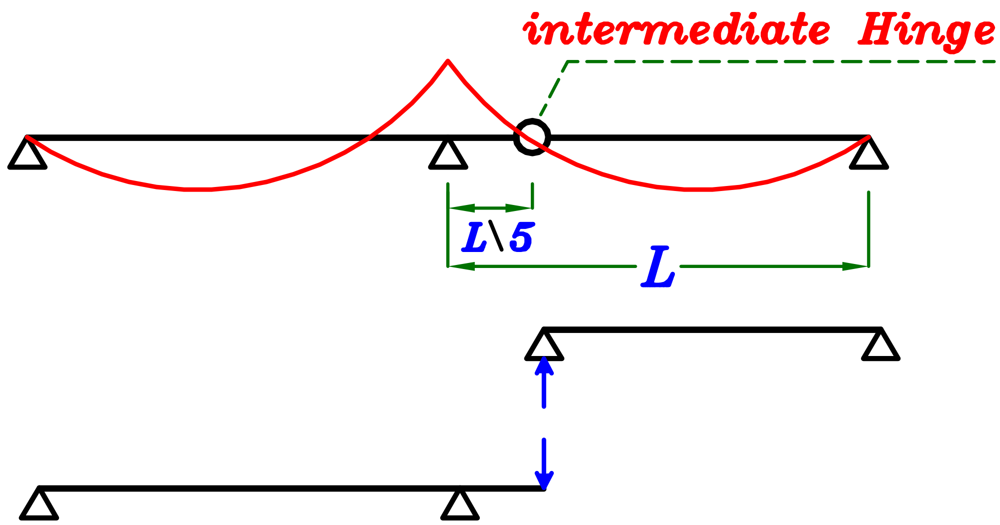
Statically Determinate Continuous Girder.

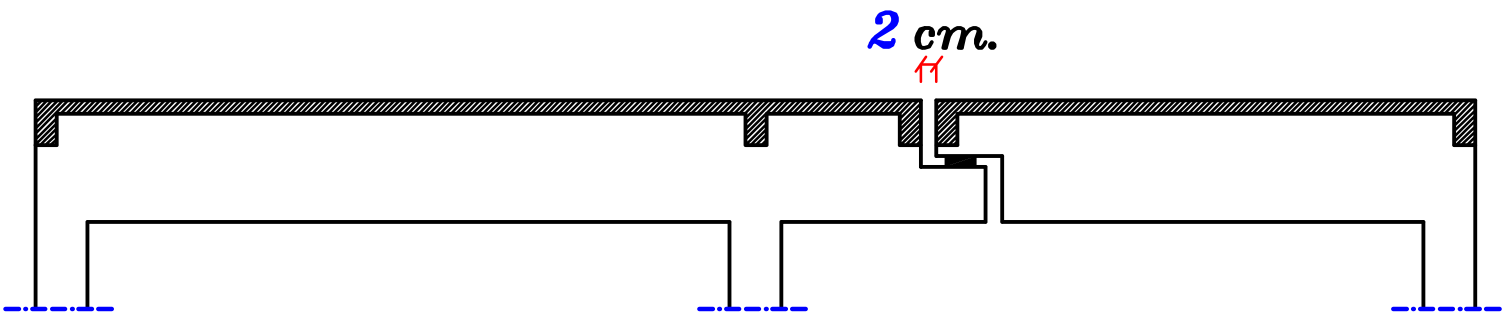
الكمرات ال *Continuous* هى كمرات *indeterminate* لذا لا تفضل فى التربه الضعيفه

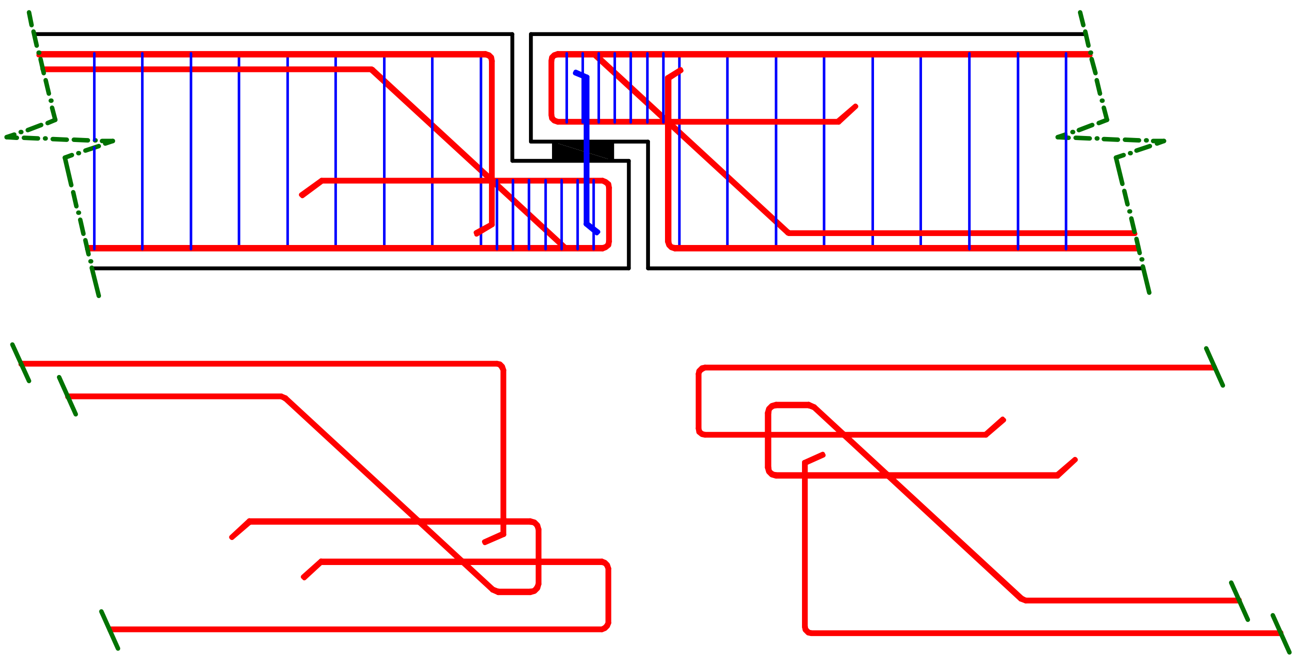
و لكن اذا احتجنا لعمل كمرات *Continuous* فى تربه ضعيفه

يفضل وضع *intermediate Hinge* لجعل الكمره *determinate*

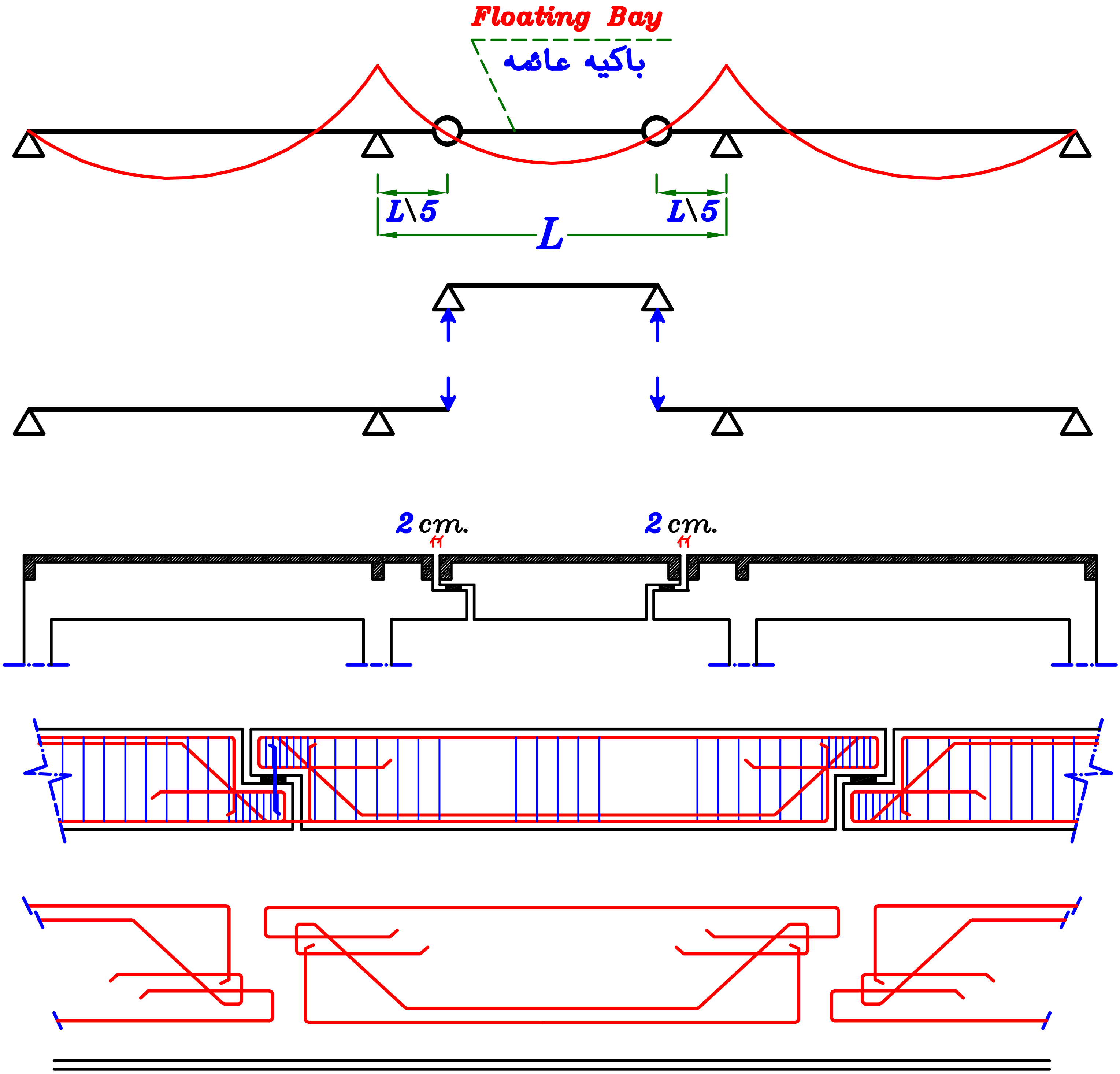
Continuous Girder (2 Spans)



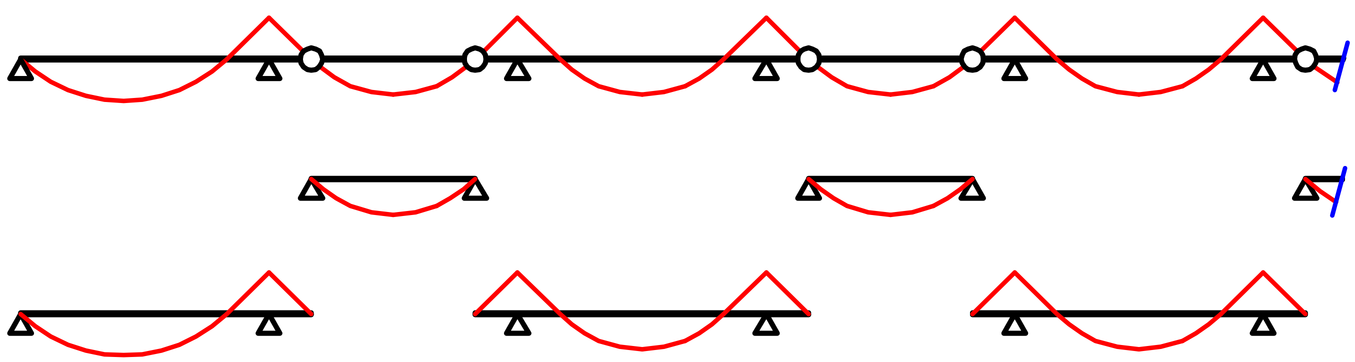




Continuous Girders (More than 2 Spans)

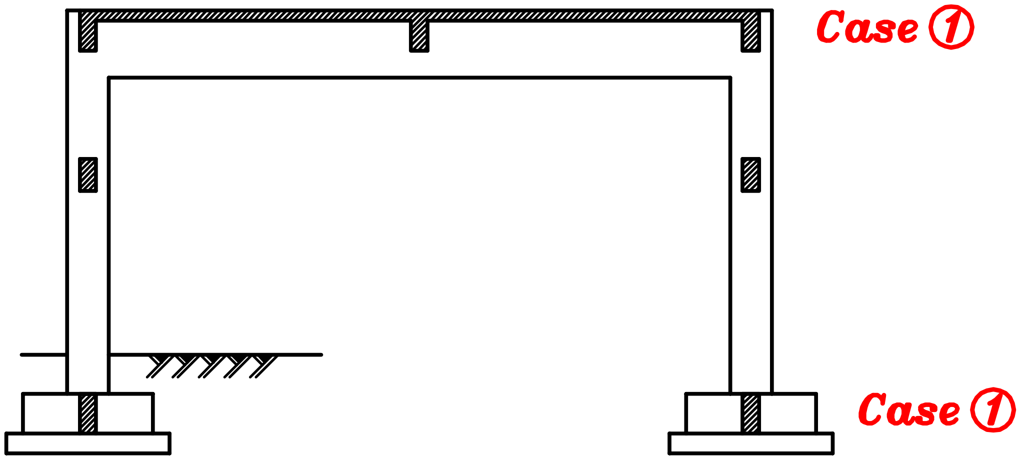


Continuous Girders (More than 3 Spans)



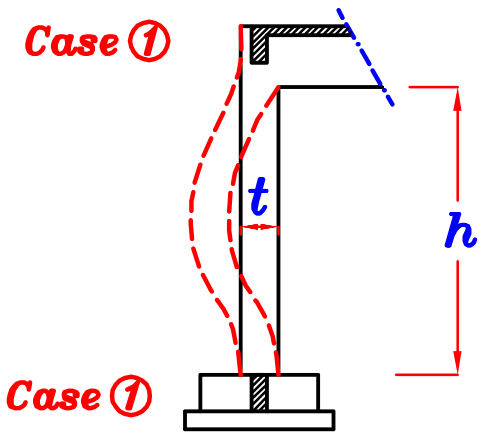
* Design the Column.

P = Reaction of the girder.



Check Buckling.

① In Plane.

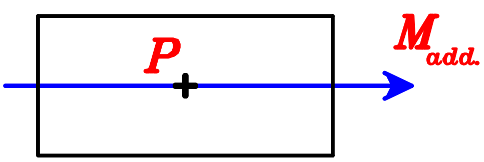


$H_o = h$

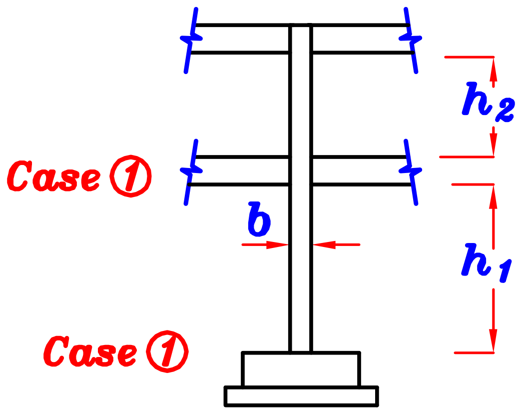
$$\lambda_b = \frac{1.2 * H_o}{t}$$

IF $\lambda_b \leqslant 10 \xrightarrow{\text{Designed}} P$ only

$\lambda_b > 10 \xrightarrow{\text{Designed}} P\ ,\ M_{add.}$



② Out of Plane

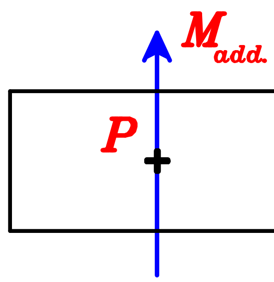


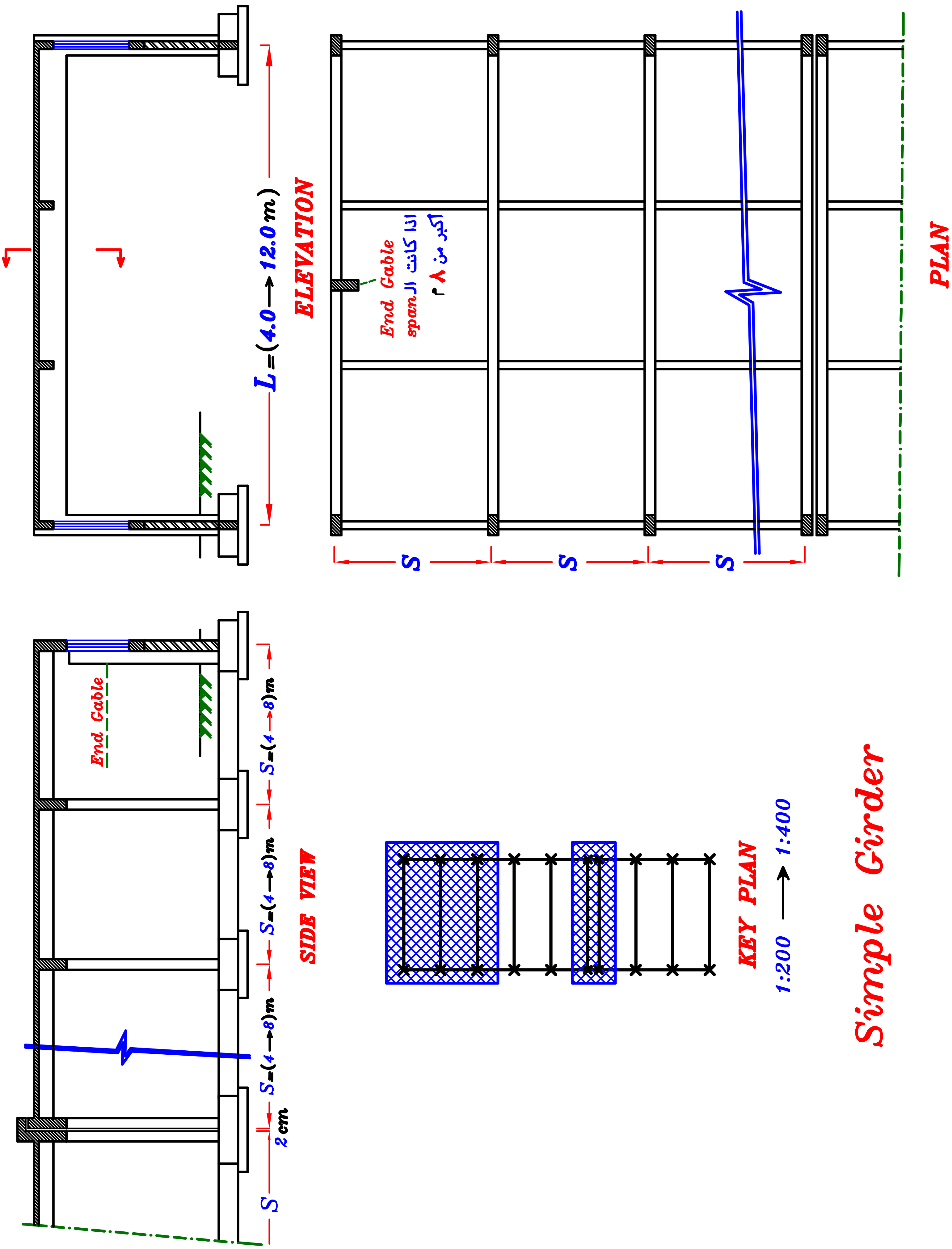
H_o = The bigger of h_1 , h_2

$$\lambda_b = \frac{1.2 * H_o}{b}$$

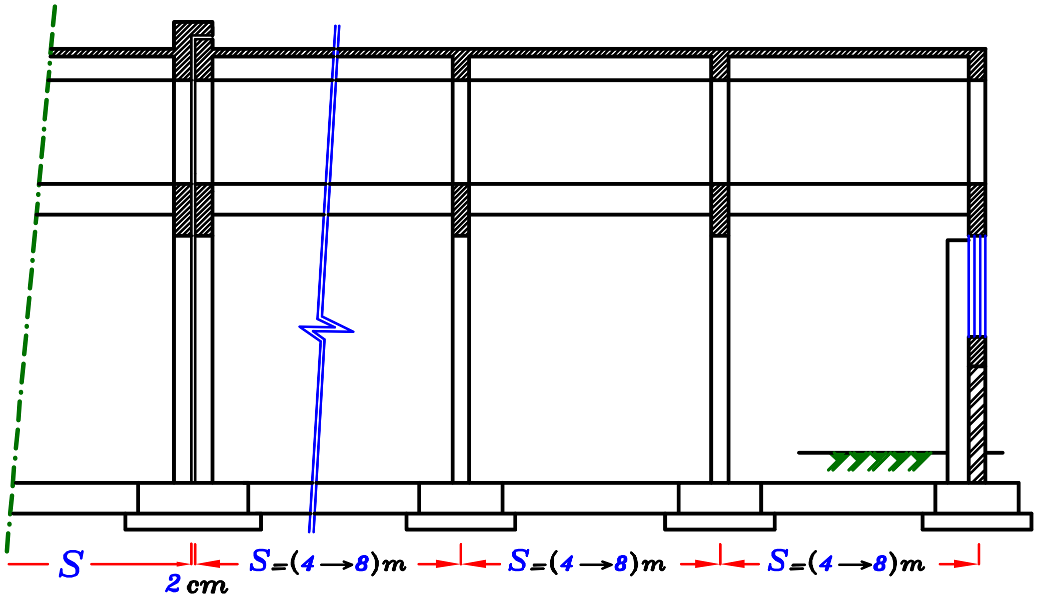
IF $\lambda_b \leqslant 10 \xrightarrow{\text{Designed}} P$ only

$\lambda_b > 10 \xrightarrow{\text{Designed}} P\ ,\ M_{add.}$

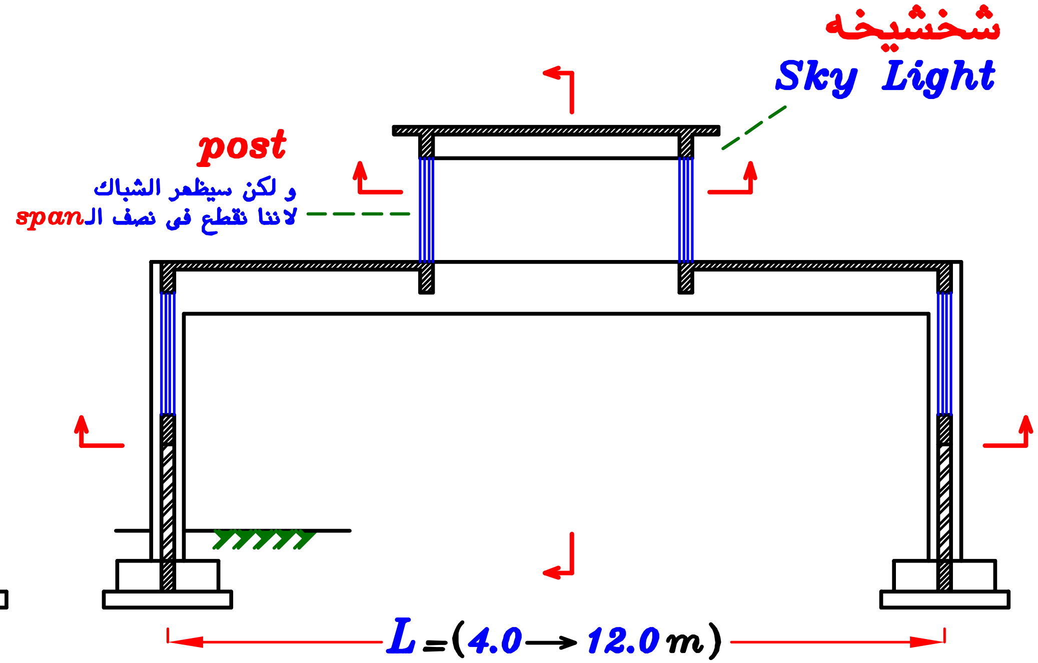




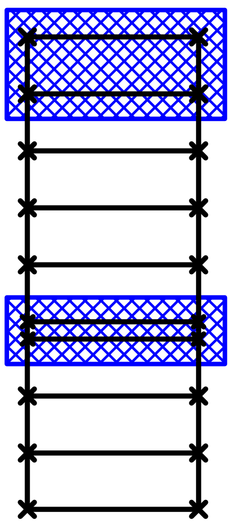
Simple Girder



SIDE VIEW

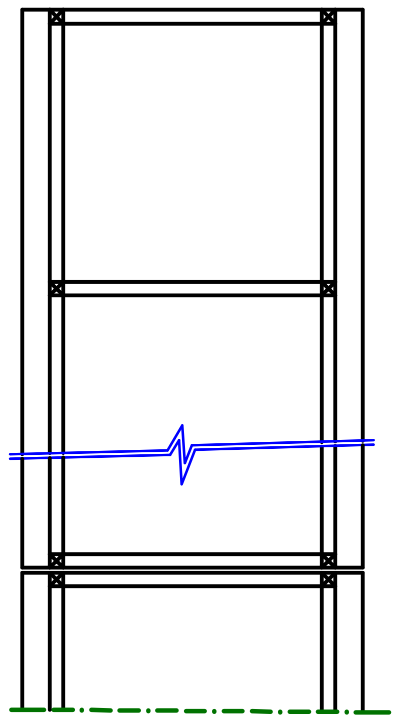


ELEVATION

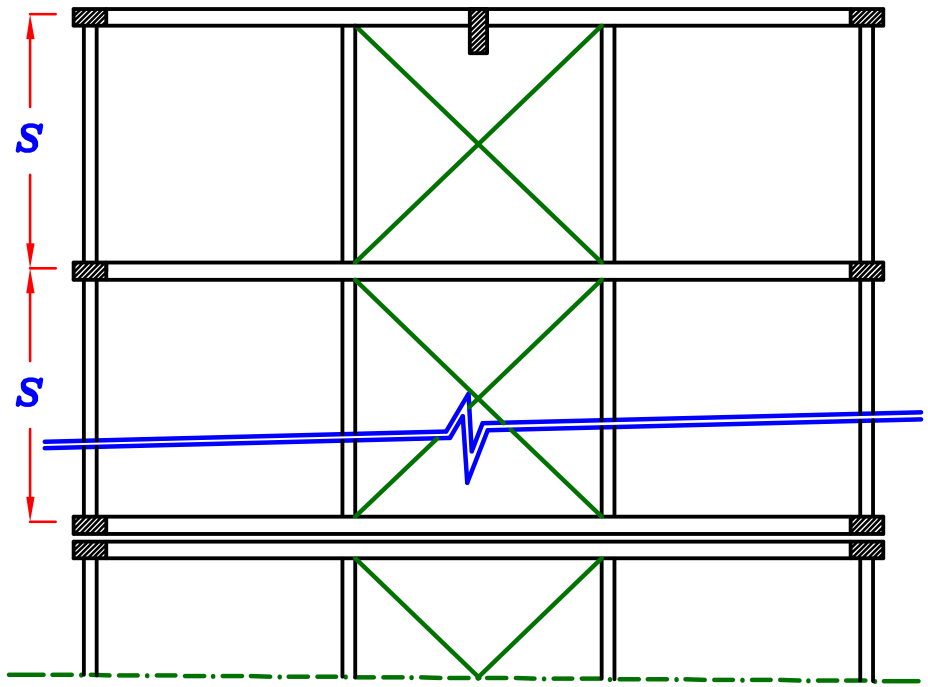


KEY PLAN

1:200 → 1:400



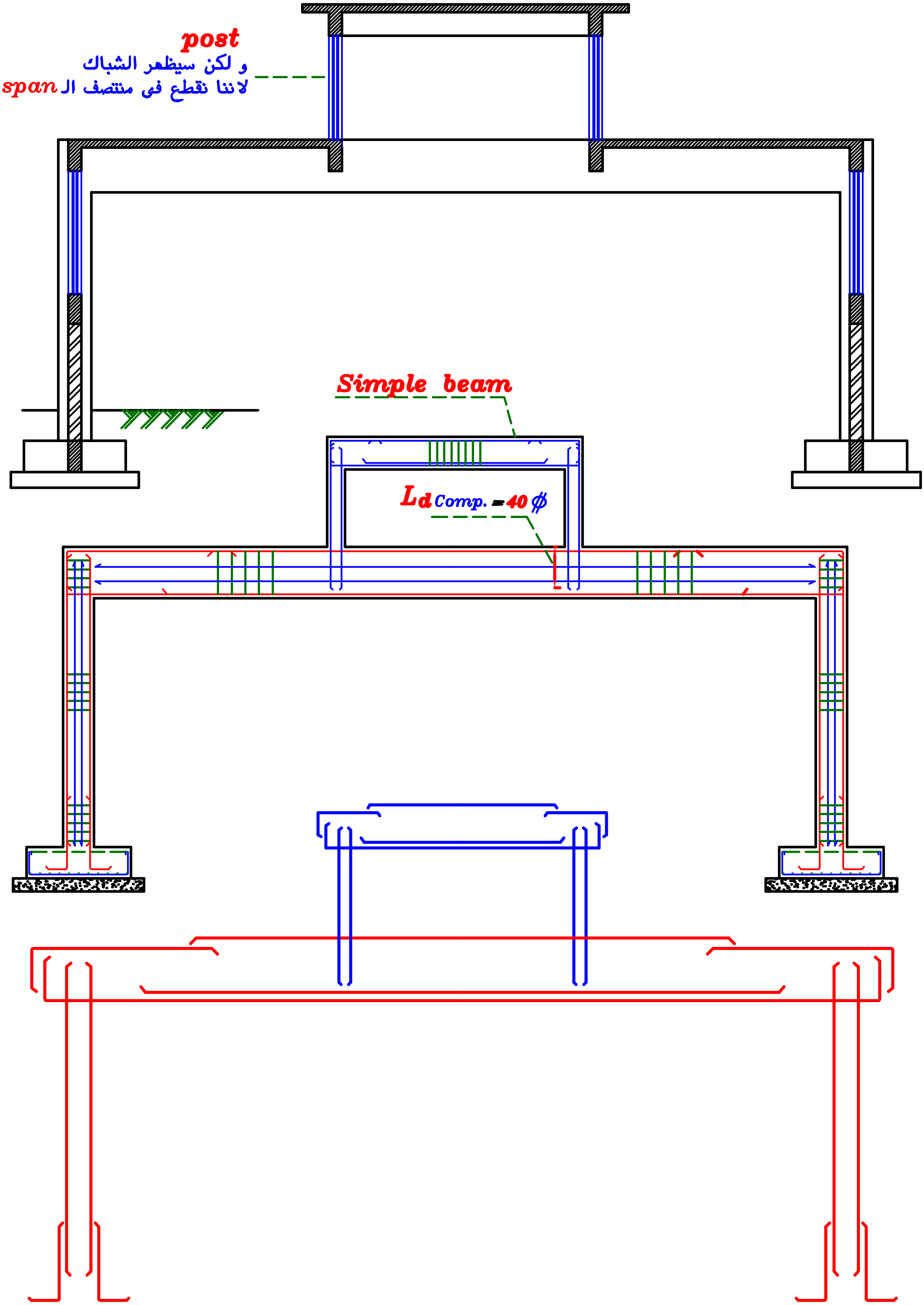
PLAN ②



PLAN ①

Simple Girder with Sky Light

Girder with Sky Light.

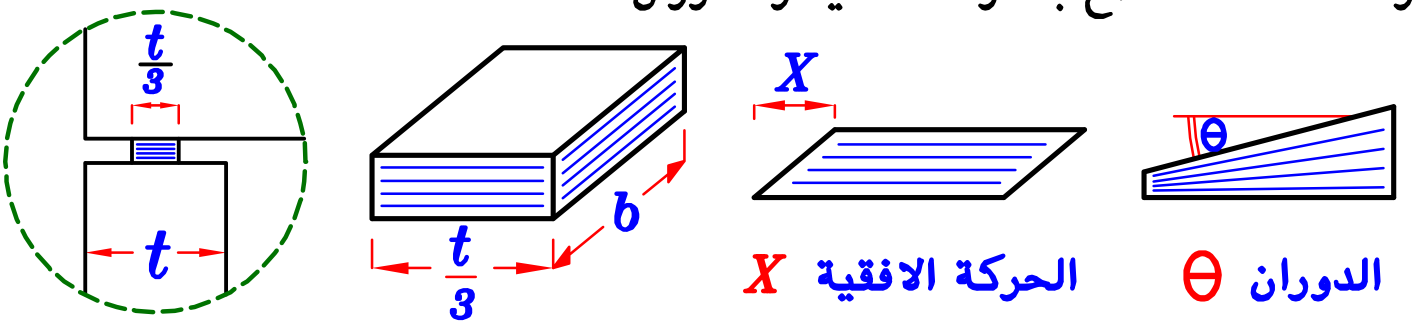


اذا اردنا أن تكون الـ **span** أكبر من ١٢,- م و لا ينتقل العزم من الكمره الى العمود
أى يظل **girder** و لا يتحول الى **Frame** نضع بين الكمره والعمود **Real support**

Real Support

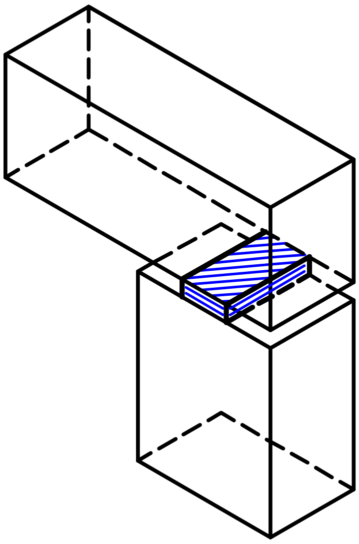
Neoprene Plate.

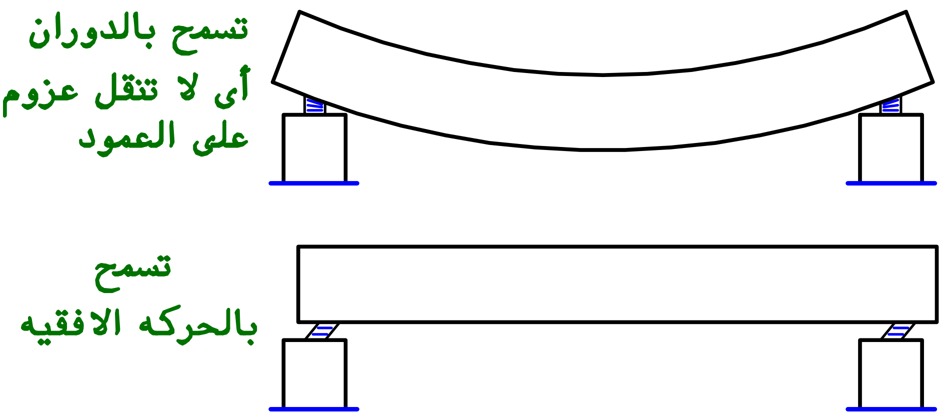
هى ألواح من الصلب بينها شرائح من المطاط المضغوط.
توضع بين العمود و الكمره أو بين العمود و القاعده لعمل **Real Hinge**
و فائدتها أنها تسمح بالحركه الافقيه و الدوران .



تسمح بالحركه الافقيه و تسمح بالدوران

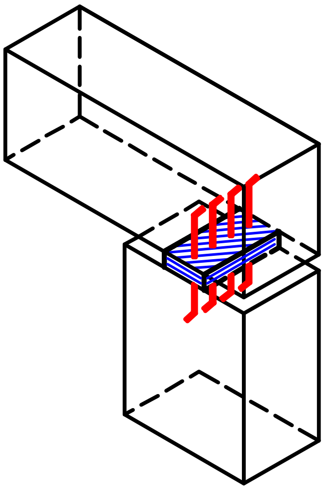
لذلك تعتبر **Roller support**

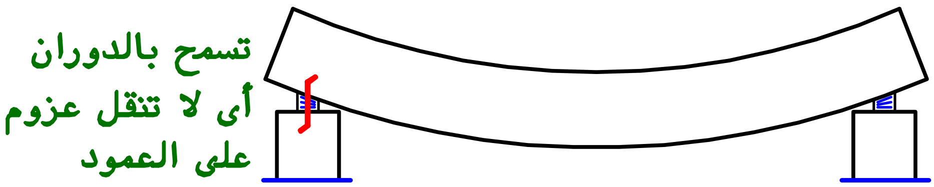




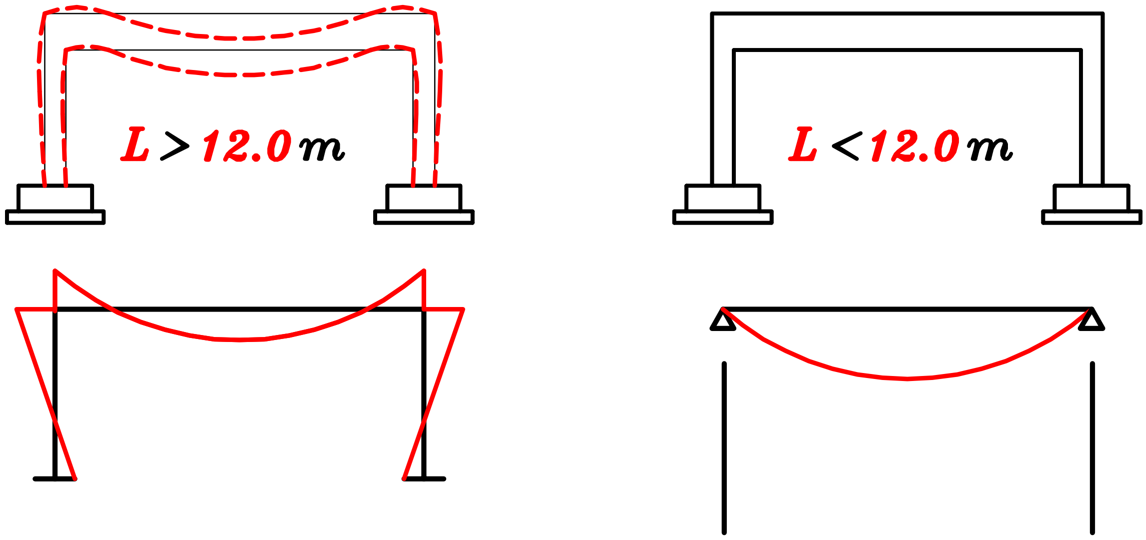
توضع صف أسياخ حديد فى المنتصف تماما
فتمنع الحركه الافقيه و لكن لا تمنع الدوران

لذلك تعتبر **Hinged support**



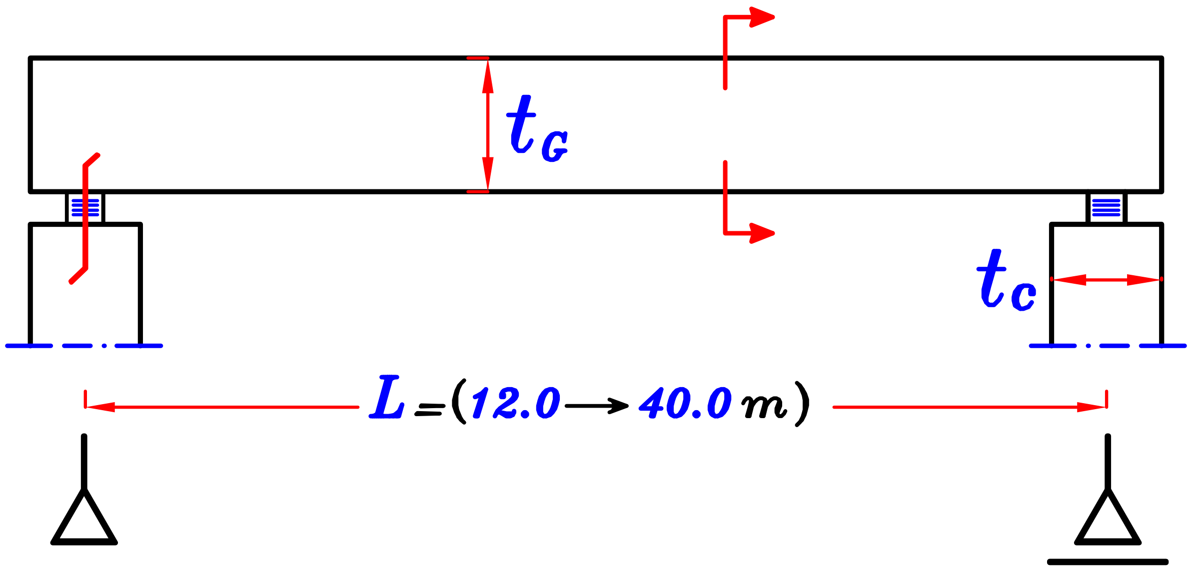


عند زياده الـ *span* الـ *Girder* عن ١٢,٠ م ينتقل العزم من الكمره الى العمود فيتحول الى *Frame*



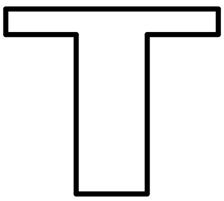
اذا اردنا أن تكون الـ *span* أكبر من ١٢,٠ م و لا ينتقل العزم من الكمره الى العمود

أى يظل *girder* و لا يتحول الى *Frame* نضع بين الكمره والعمود *Real support*

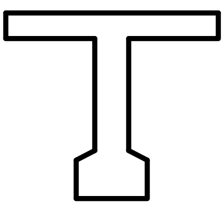


$$\boxed{t_G = \frac{L}{10}}$$

$$\boxed{t_c = \frac{H}{8 \rightarrow 9}}$$



when $L = (12.0 \rightarrow 20.0\,m)$



when $L = (20.0 \rightarrow 40.0\,m)$

يفضل لتقليل الـ *o.w.*

خطوات مسأله ال Systems

١ـ اختيار ال system .

٢ـ رسم .Dim concrete فى ال Plan & elevation .

٣ـ رسم تسليح البلاطه على نفس ال Plan .

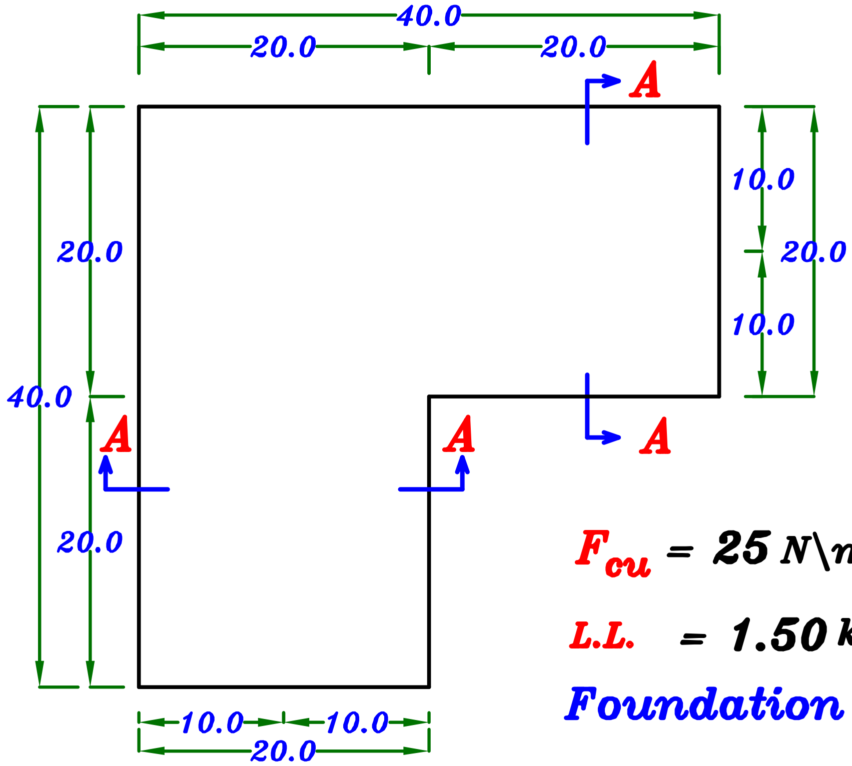
٤ـ عمل Load distribution للبلاطات و حساب الاحمال على ال System .

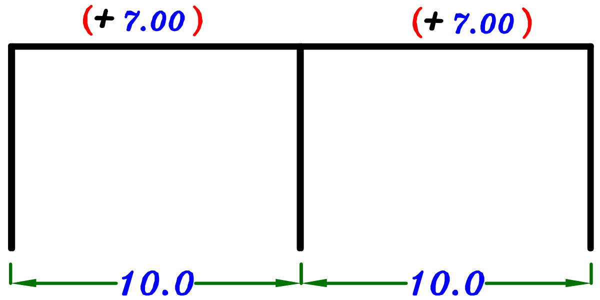
٥ـ حل ال System و رسم .B.M.D. & N.F.D .

٦ـ تصميم قطاعات ال System على M,N .

٧ـ رسم التسليح و التفريد فى ال elevation .

Example.





Sec. A–A

F_{cu} = 25 N\mm^2 , F_y = 360 N\mm^2

L.L. = 1.50 kN\m^2 , F.C. = 2.0 kN\m^2

Foundation Level. = – 2.0 m

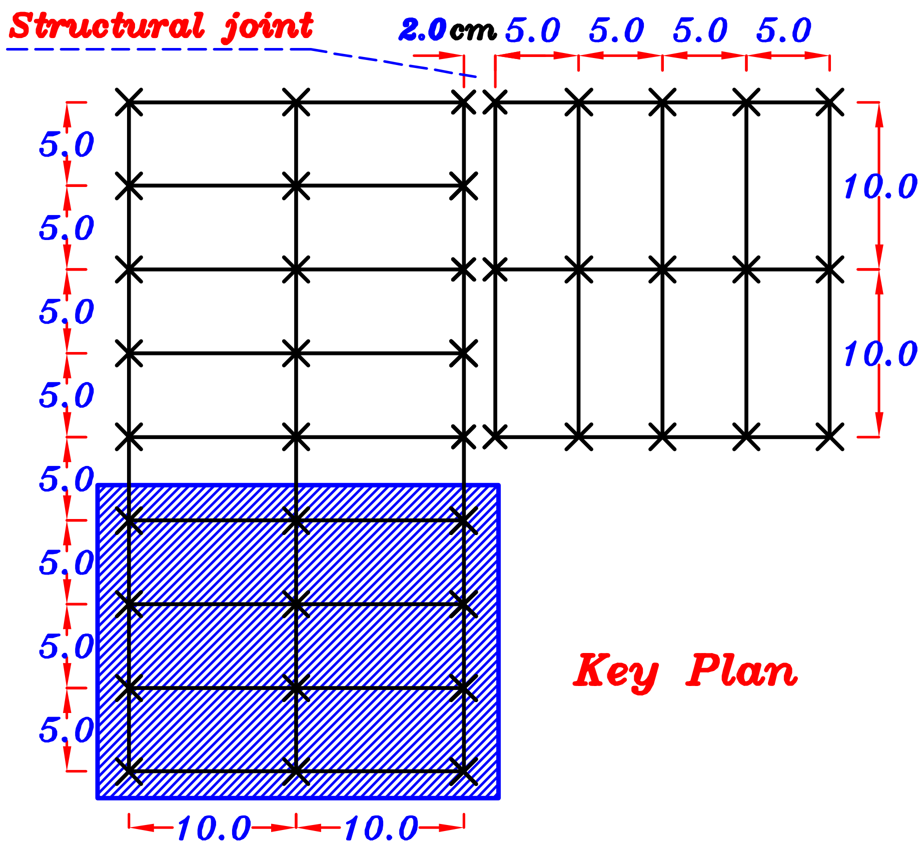
Req.

1 – Draw concrete Dimensions in elevation.

2 – Show the statical system For the main system.

3 – Design the slabs & Draw its RFT. in plan.

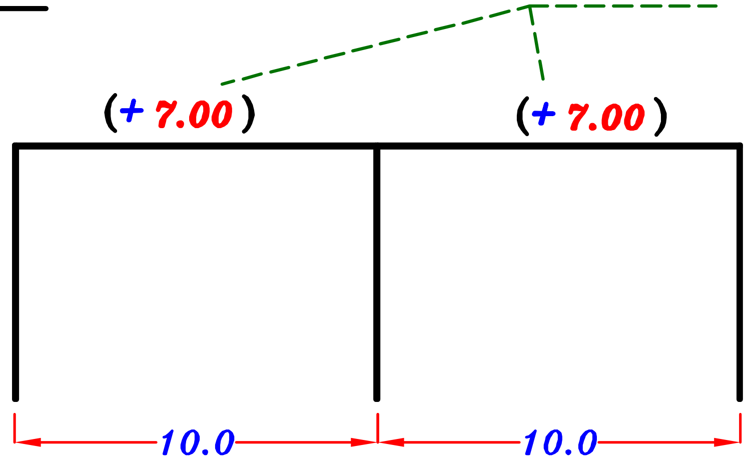
4 – Design the Main system and draw its RFT. in elevation & Cross–Sec.



Key Plan

Concrete Dimensions.

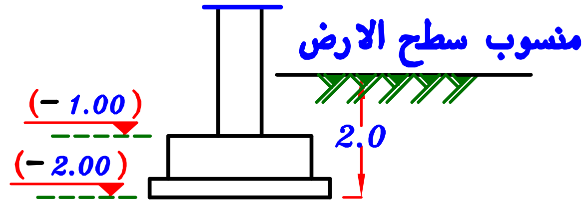
منسوب البلاطه من أعلى



الشكل المعطى فى المعطى فى المسأله هو شكل البلاطه

و ليس شرط أن يكون شكل الـ **system**

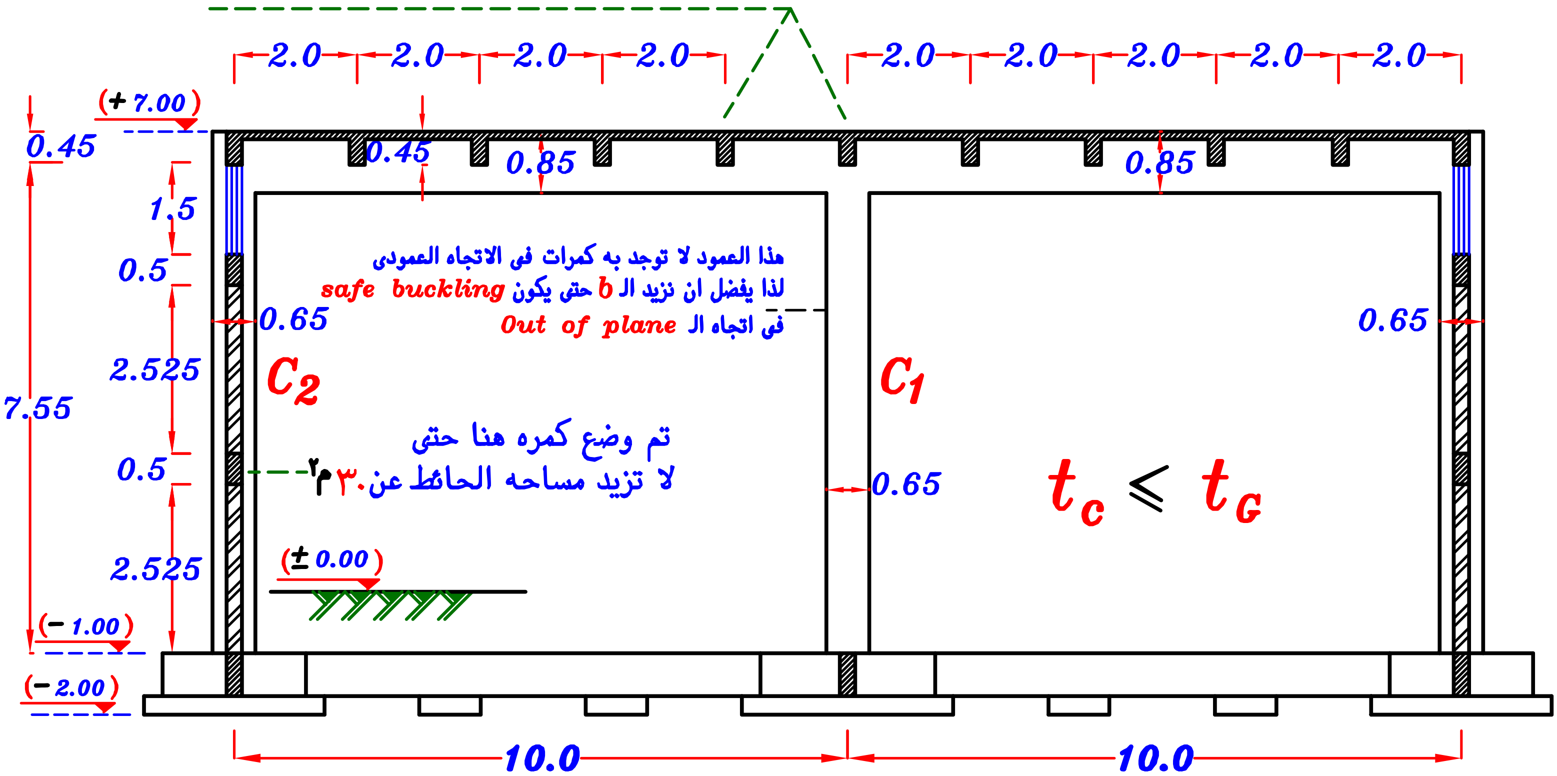
Foundation Level. $= -\,2.0\ m$



Foundation Level.

يفضل للتسهيل اذ تكون المسافات بين الكمرات الـ **secondary** صغيره

حتى تكون البلاطات **one way** فتكون أسهل فى الحسابات



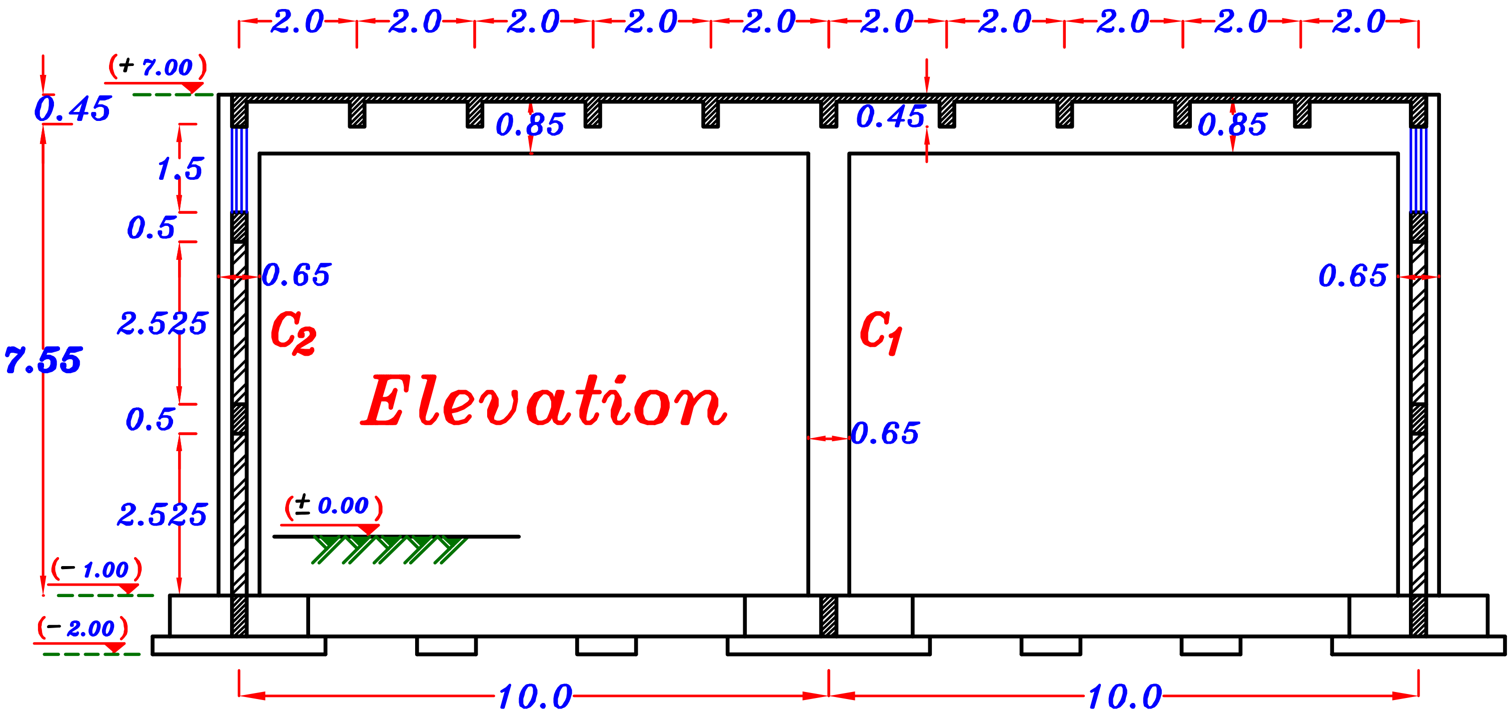
$$t_G = \frac{L}{12} = \frac{10}{12} = 0.833 = 0.85\ m$$

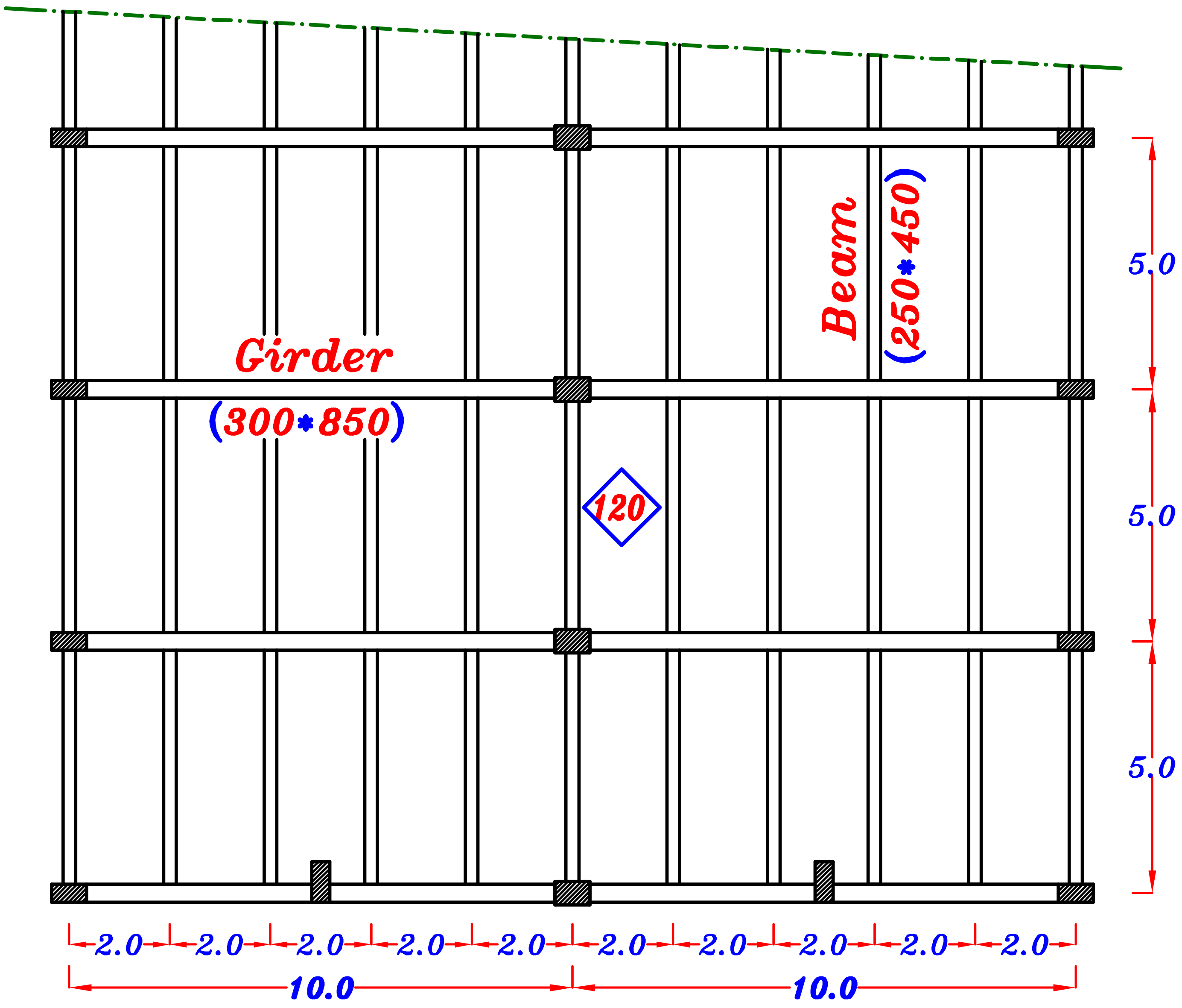
$b = 0.30\ m$ **but For column** C_1 $\quad b = 0.40\ m$

$$t_c \simeq 0.7\ t_G = 0.65\ m$$

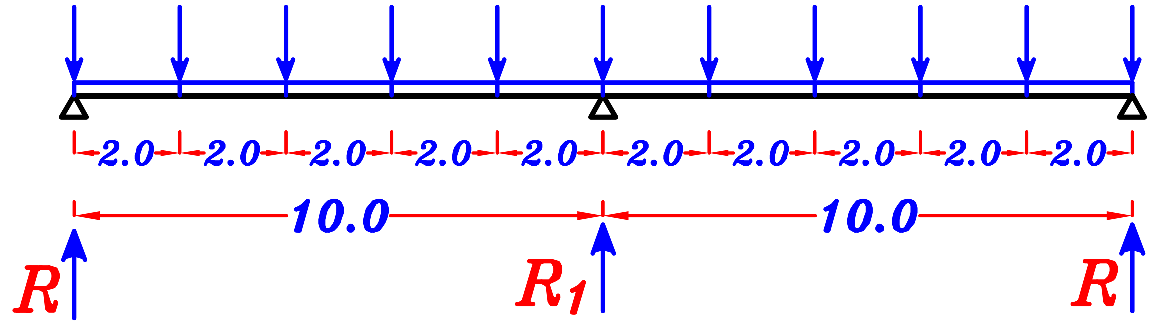
$$t_{sec.B} = \frac{spacing}{12} = \frac{5.0}{12} = 0.416 = 0.45\ m$$

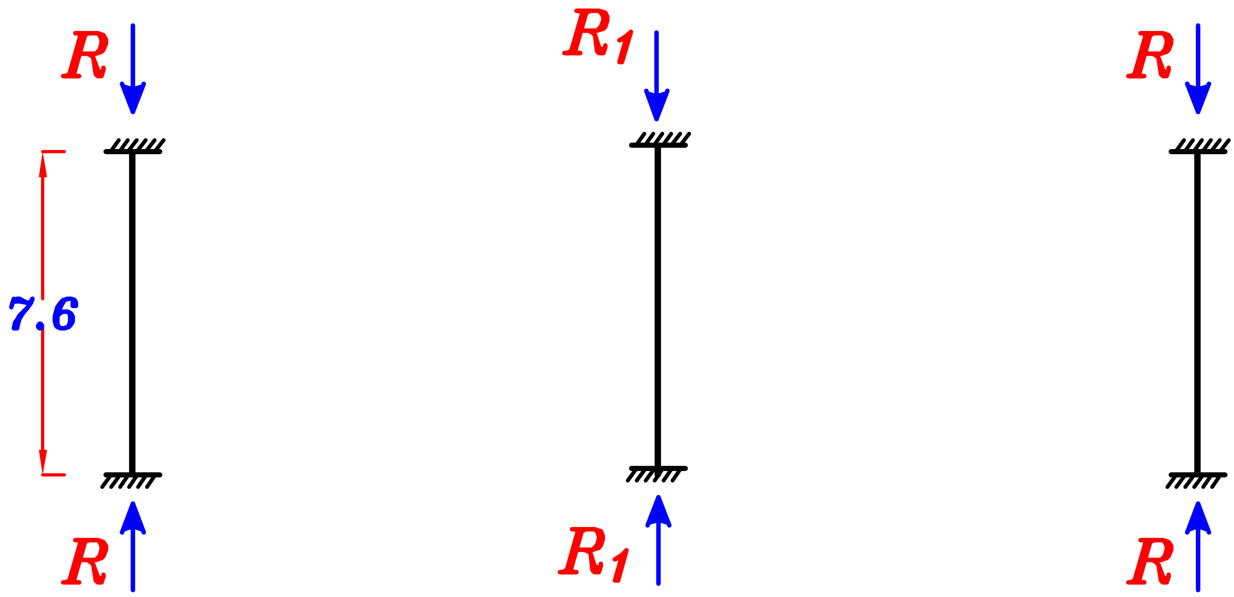
Plan Concrete Dimensions.



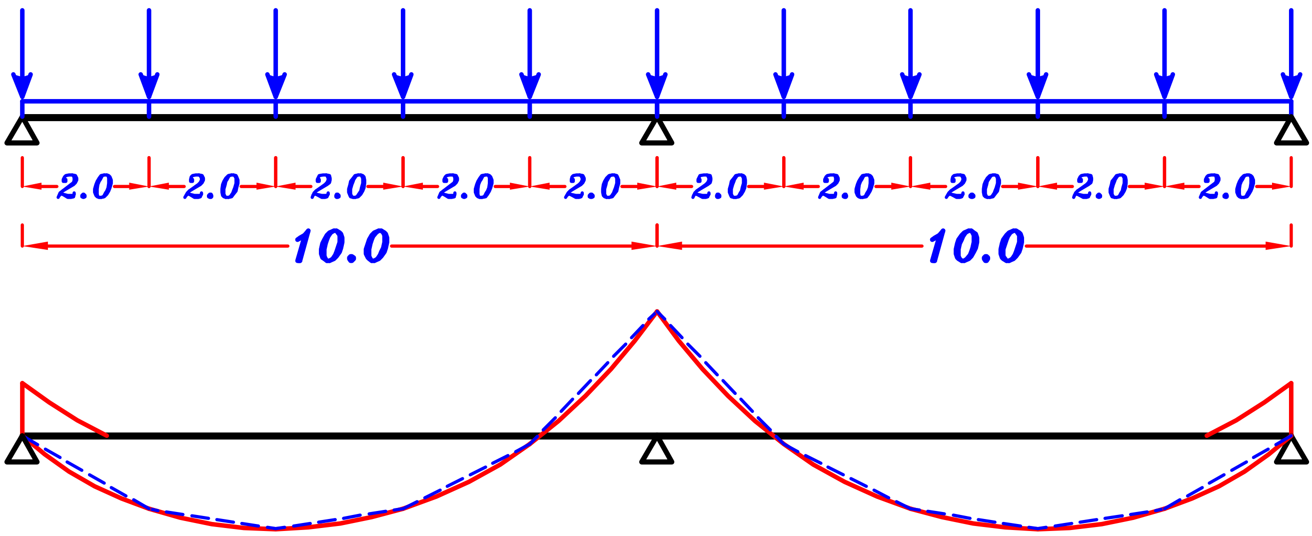


Plan





Girders Designed on M

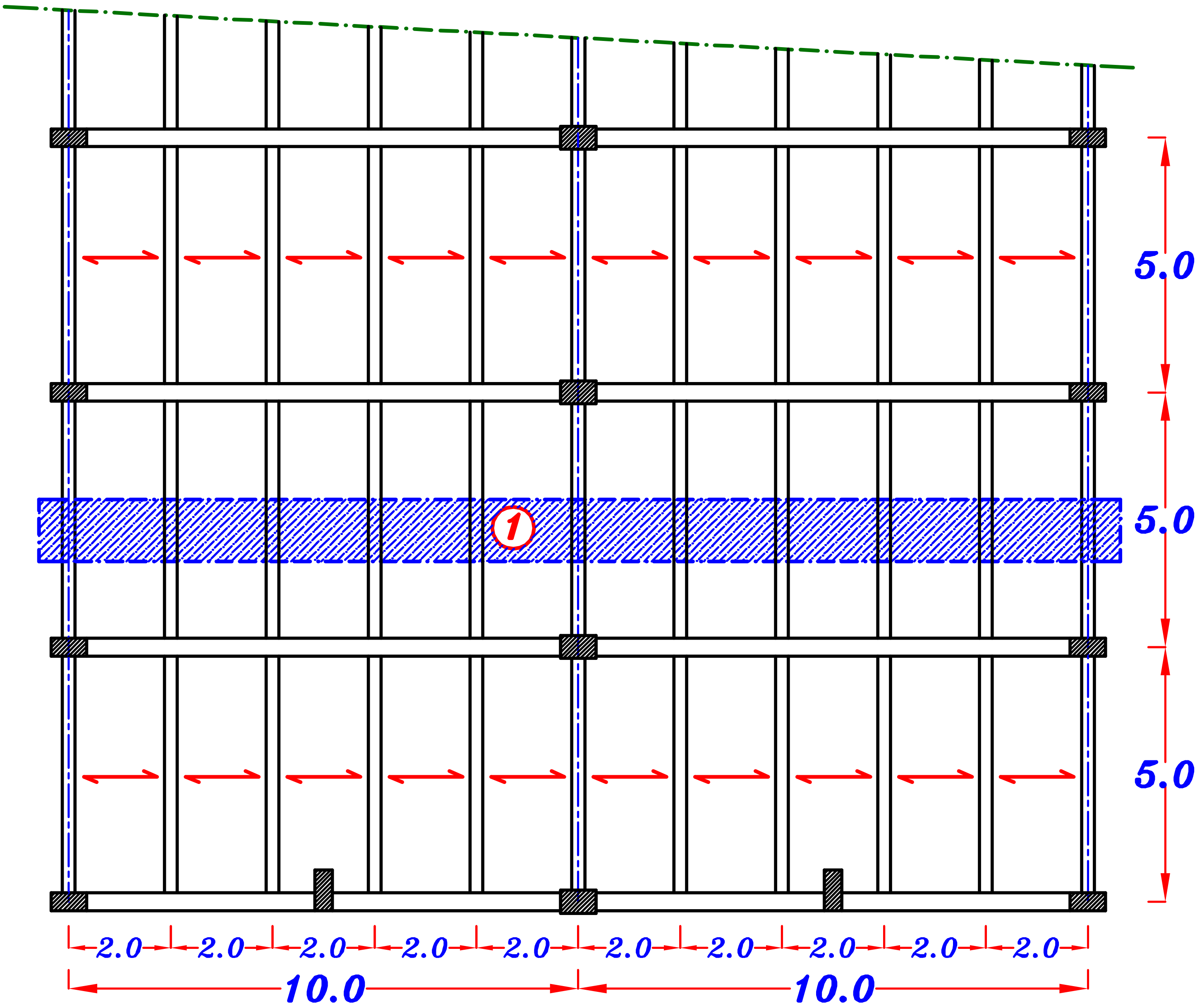


Columns

Check Buckling

and Designed on P, M_{add}

Design of slabs.



t_s

$$t_s = \frac{L_s}{30} = \frac{2000}{30} = 66.7 \ mm \qquad \text{take} \quad \boxed{t_s = 120 \ mm}$$

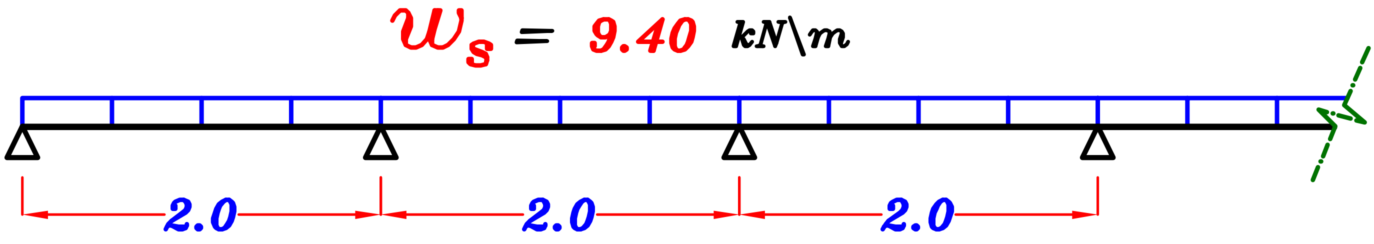
w_s

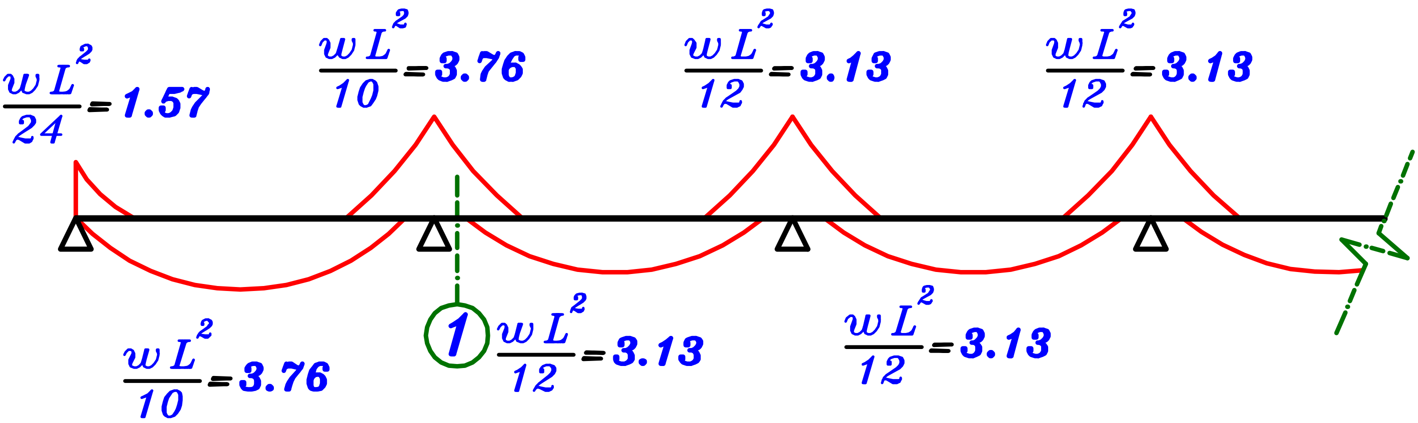
$$(w_s)_{U.L.} = 1.4\,(t_s\,\gamma_c + F.C.) + 1.6\,(L.L.)$$

$$(w_s)_{U.L.} = 1.4\,(0.12 * 25 + 2.0) + 1.6\,(1.50) = 9.40 \ kN\backslash m^2$$

$$\boxed{w_s = 9.40 \ kN\backslash m^2}$$

Strip (1)





Sec. 1

$M_{U.L.} = 3.76$ kN.m\m

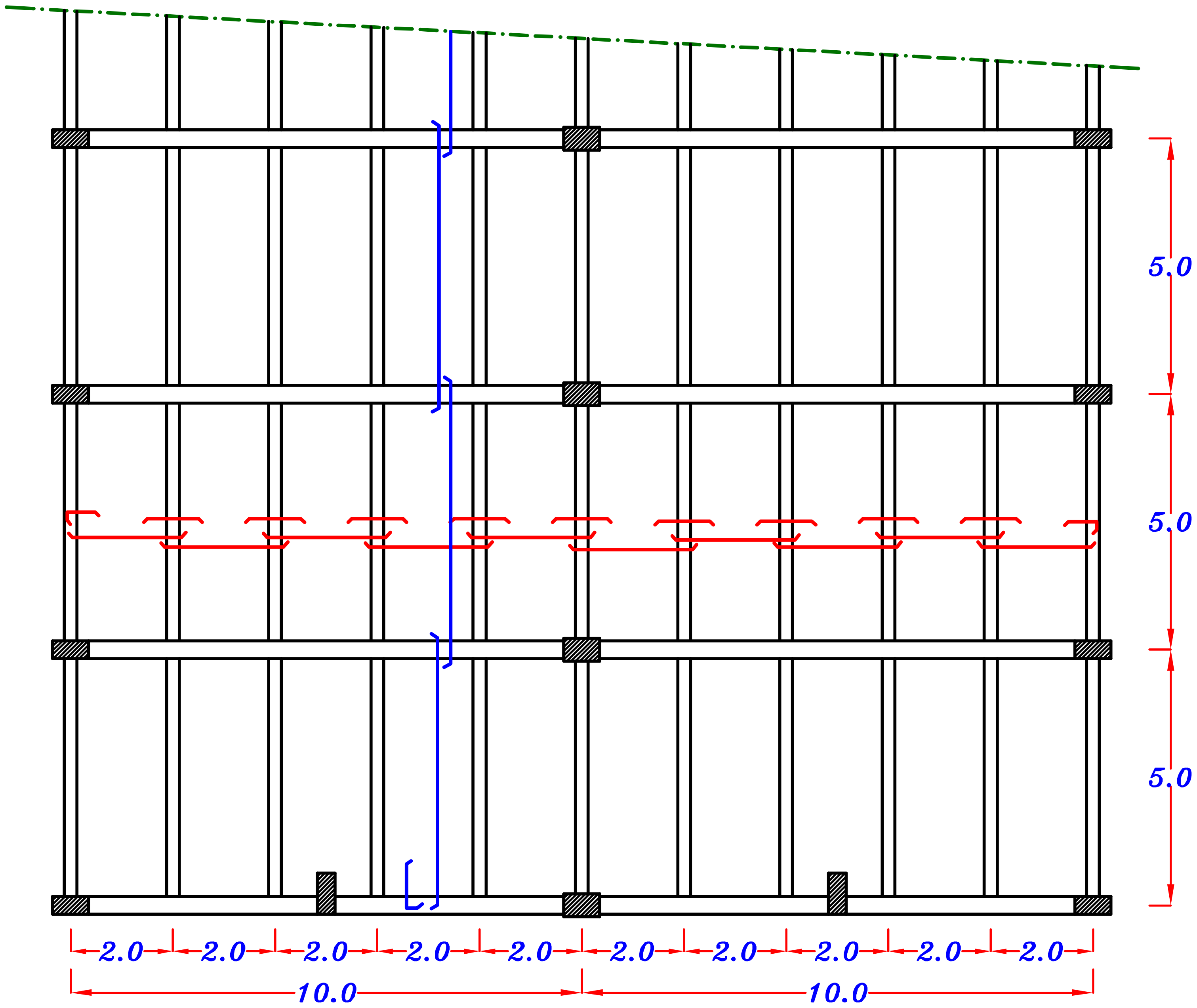
$t_s = 120$ mm , $d = 100$ mm

$$100 = C_1\sqrt{\frac{3.76 * 10^6}{25 * 1000}} \longrightarrow C_1 = 8.15 \longrightarrow J = 0.826$$

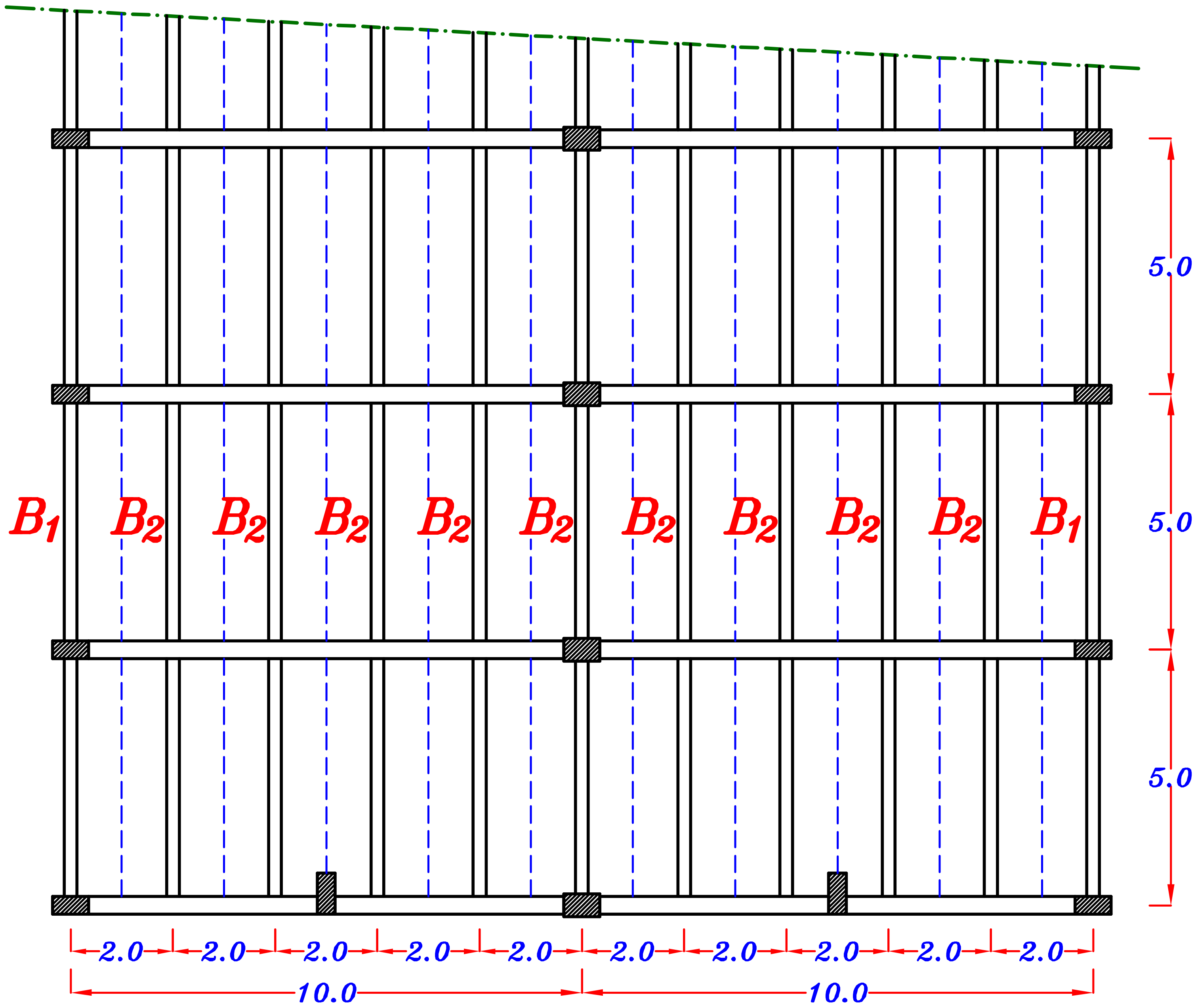
$$A_s = \frac{3.76 * 10^6}{0.826 * 360 * 100} = 126.4 \ mm^2/m'$$

$5 \phi 10 \backslash m'$

RFT. of the Slabs.



Loads on Beams.



$o.w.$ of Beams & Girder $= 1.4\, b\, t\, \gamma_c$

Beams $(250 * 450)$ $o.w. = 1.4\ (0.25)(0.45)(25) = 3.90\ kN\backslash m'$

Girder $(300 * 850)$ $o.w. = 1.4\ (0.30)(0.85)(25) = 8.90\ kN\backslash m'$

B_1

$$w_a = w_e = o.w. + \boxed{}\, w_s \frac{L_s}{2}$$

$$= 3.90 + (9.40)\left(\frac{2.0}{2}\right) = 13.30\ \ kN\backslash m'$$

$$R_1 = w_a * Spacing = 13.30 * 5.0 = 66.5\ \ kN$$

$$\boxed{R_1 = 66.5\ \ kN}$$

B_2

$$w_a = w_e = o.w. + 2\ \boxed{}\, w_s \frac{L_s}{2}$$

$$= 3.90 + 2\,(9.40)\left(\frac{2.0}{2}\right) = 22.7\ \ kN\backslash m'$$

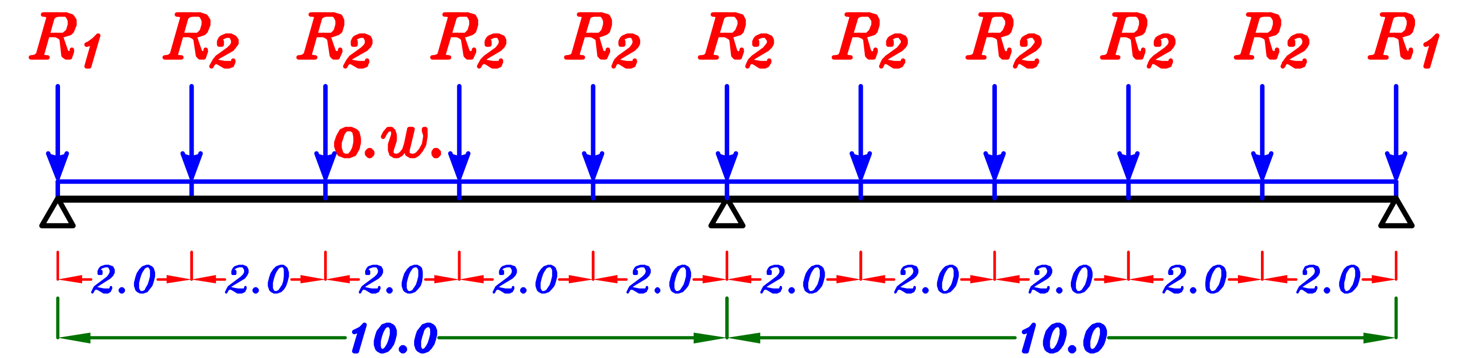
$$R_2 = w_a * Spacing = 22.7 * 5.0 = 113.5\ kN$$

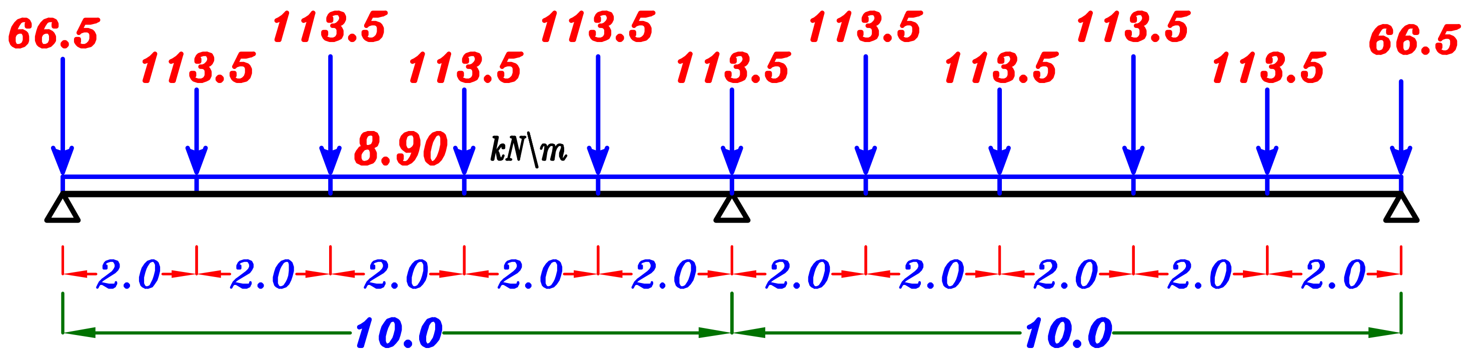
$$\boxed{R_2 = 113.5\ kN}$$

Loads on the Girder.

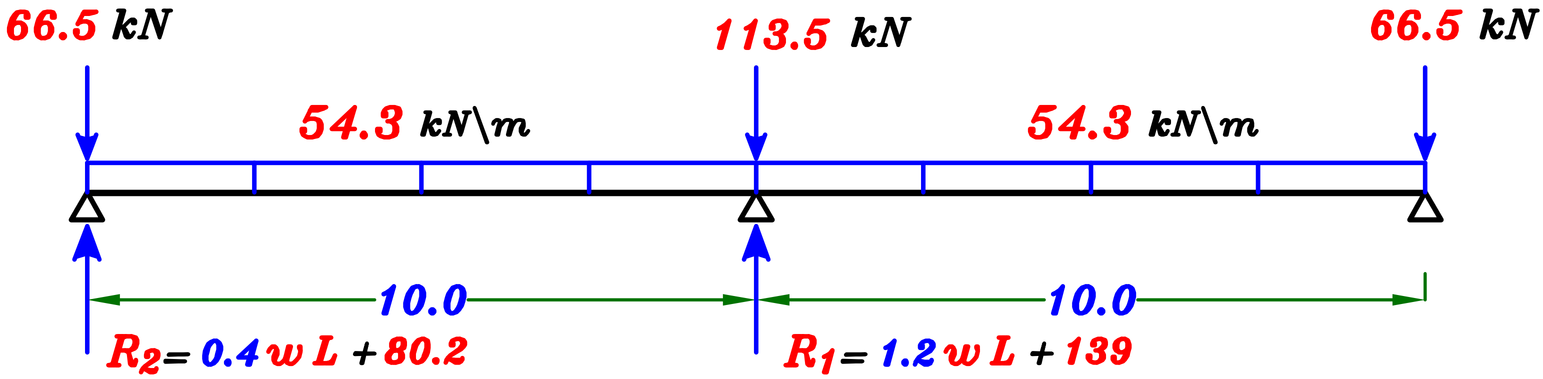
o.w. of Girder (300 * 850)

$o.w. = 1.4\,(0.30)\,(0.85)\,(25) = 8.90$ kN\m\`





$$w = o.w. + \frac{\sum P}{span} = 8.90 + \frac{4\,(113.5)}{10.0} = 54.3 \text{ kN\m`}$$

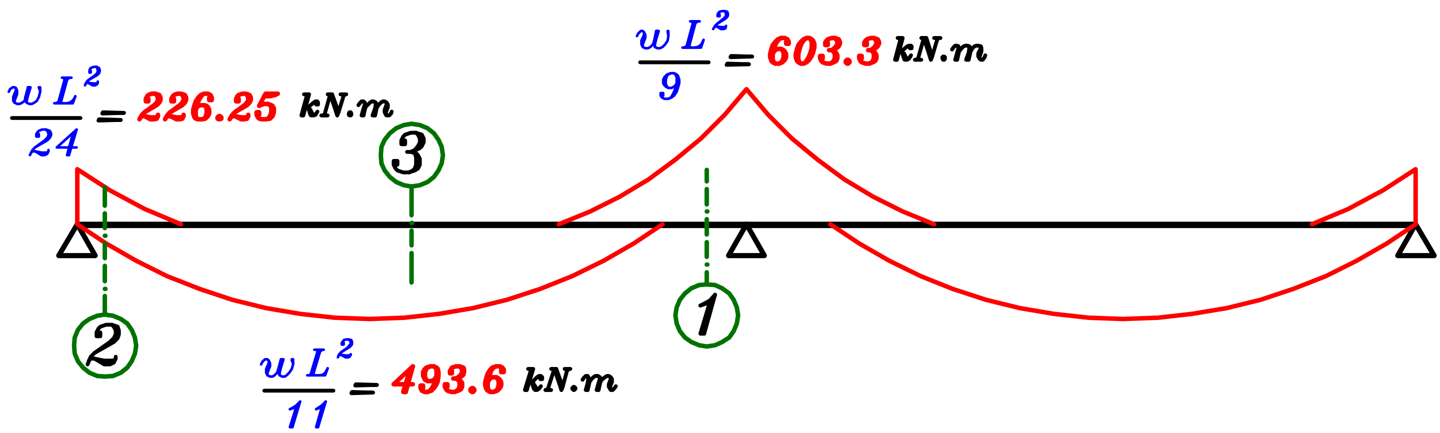


$R_2 = 0.4\,w\,L + 80.2$

$= 0.4 * 54.3 * 10 + 66.5 = 283.7$ kN

$R_1 = 1.2\,w\,L + 139$

$= 1.2 * 54.3 * 10 + 113.5 = 765.1$ kN



Sec. ① $M_{U.L.} = 603.3$ kN.m R−Sec.

Take $d = 0.80$ m (as taken in the concrete dimensions)

$$800 = C_1 \sqrt{\frac{603.3 * 10^6}{25 * 300}} \longrightarrow C_1 = 2.82 \longrightarrow J = 0.721$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{603.3 * 10^6}{0.721 * 360 * 800} = 2905.4 \ mm^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 2905.4 \ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 800 = 750 \ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 2905.4 \ mm^2 \qquad 8 \phi 22$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{300 - 25}{22 + 25} = 5.85 = 5.0 \text{ bars}$$

Sec. ② $M_{U.L.} = 226.25$ kN.m R−Sec.

$$\therefore 800 = C_1 \sqrt{\frac{226.25 * 10^6}{25 * 300}} \longrightarrow C_1 = 4.60 \longrightarrow J = 0.82$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{226.25 * 10^6}{0.82 * 360 * 800} = 958.0 \ mm^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 958.0 \ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 800 = 750 \ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 958.0 \ mm^2 \qquad 3 \phi 22$$

Sec. ③ $M_{U.L.} = 493.6$ kN.m T–Sec.

Take $d = 0.80$ m (as taken in the concrete dimensions)

$$B = \begin{cases} C.L. - C.L. = Spacing = 5.0\ m = 5000\ mm \\ 16\ t_s + b = 16 * 120 + 300 = 2220\ mm \\ K \frac{L}{5} + b = 0.8 * \frac{10000}{5} + 300 = 1900\ mm \end{cases}$$

$$\boxed{B = 1900\ mm}$$

$$\therefore 800 = C_1 \sqrt{\frac{493.6 * 10^6}{25 * 1900}} \longrightarrow C_1 = 7.84 \longrightarrow J = 0.826$$

$$\therefore A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{493.6 * 10^6}{0.826 * 360 * 800} = 2075\ mm^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 2075$ mm

$$\mu_{min.}\ b\ d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\ d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 800 = 750\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.} b\ d$ $\therefore$ Take $A_s = A_{s_{req.}} = 2075\ mm^2$ 6 ϕ22

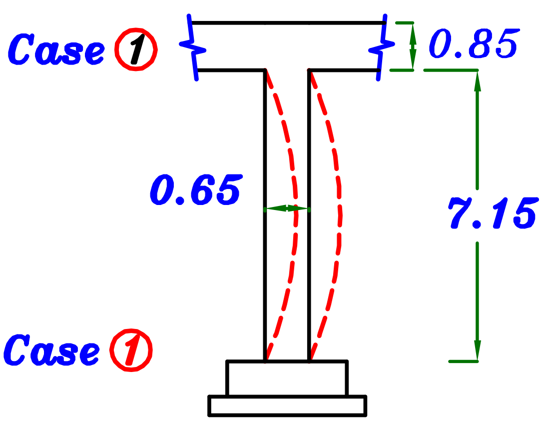
Stirrup Hangers $= (0.1 \rightarrow 0.2)\ A_s = (0.1 \rightarrow 0.2)\ 2075$ 3 ϕ12

Design of the Columns.

Column C_1

$P = R_1 = 765.1$ kN

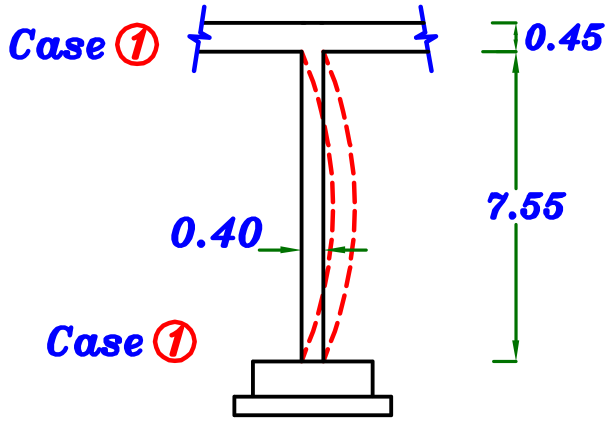
① In Plane.



$H_o = 7.15$ m

$$\lambda_b = \frac{K * H_o}{t} = \frac{1.2 * 7.15}{0.65} = 13.2 > 10$$

② Out of Plane.



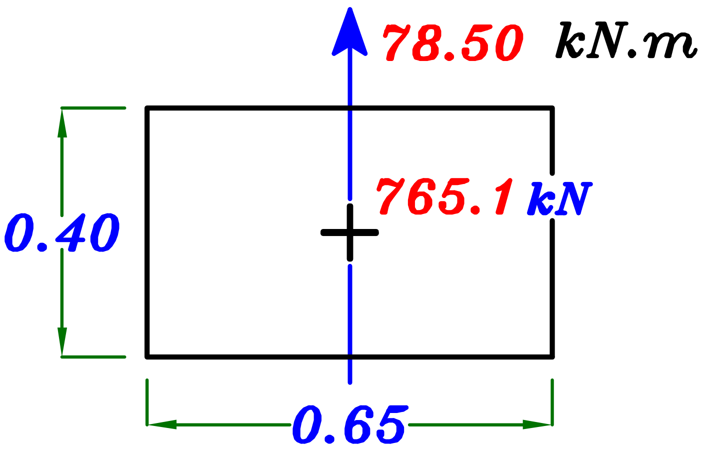
$H_o = 7.55$ m

$$\lambda_b = \frac{K * H_o}{b} = \frac{1.2 * 7.5}{0.40} = 22.65 < 23$$

∴ The column is long at out of plane direction.

$$\delta = \frac{(\lambda_b)^2 * b}{2000} = \frac{22.65^2 * 0.40}{2000} = 0.1026 \text{ m}$$

$$M_{add.} = P * \delta = 765.1 * 0.1026 = 78.50 \text{ kN.m}$$



$$e = \frac{M}{P} = \frac{78.50}{765.1} = 0.101\ m \quad \therefore \frac{e}{t} = \frac{0.1026}{0.40} = 0.256 < 0.5 \xrightarrow{use} I.D.$$

$$\zeta = \frac{0.4-0.1}{0.4} = 0.75 = 0.7 \xrightarrow{use} \text{ECCS Page 4-25}$$

$$\left.\begin{aligned} \frac{P_U}{F_{cu}\, b\, t} &= \frac{765.1 * 10^3}{25 * 650 * 400} = 0.117 \\ \frac{M_U}{F_{cu}\, b\, t^2} &= \frac{78.50 * 10^6}{25 * 650 * 400^2} = 0.030 \end{aligned}\right\} \rho < 1.0 \xrightarrow{Take} \rho = 1.0$$

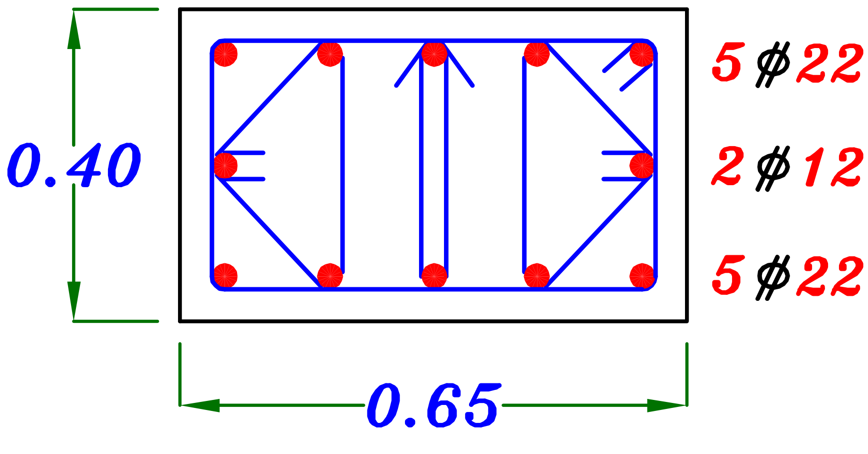
$$A_s = A_s` = \mu * b * t = \rho * F_{cu} * 10^{-4} * b * t = 1.0 * 25 * 10^{-4} * 650 * 400 = 650\ mm^2$$

$$A_{s\,total} = A_s + A_s` = 1300\ mm^2$$

$$A_{s_{min}} = \frac{0.25 + 0.052\ \lambda_{max}}{100} * b * t$$

$$= \frac{0.25 + 0.052\ (22.65)}{100} * 650 * 400 = 3712.28\ mm^2 > A_{s\,total}$$

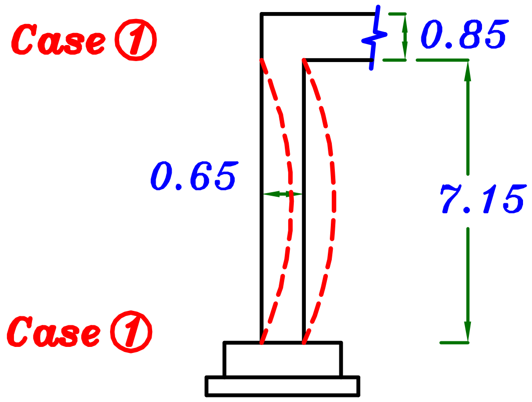
$$A_s = A_s` = \frac{3712.28}{2} = 1856.14\ mm^2 \qquad 5 \phi 22$$



Column C2

$P = R_2 = 283.7 \quad kN$

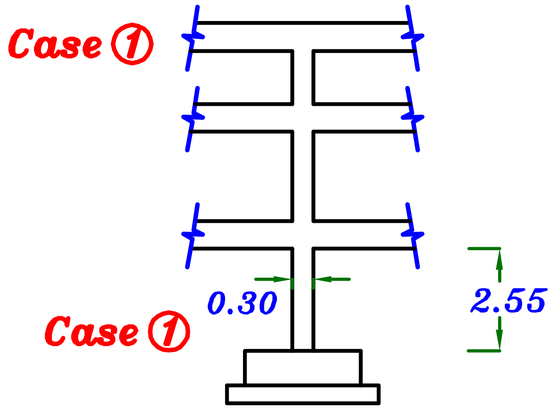
① In Plane.



$H_o = 7.15 \; m$

$$\lambda_b = \frac{K * H_o}{t} = \frac{1.2 * 7.15}{0.65} = 13.2 > 10$$

② Out of Plane.



$H_o = 2.55 \; m$

$$\lambda_b = \frac{K * H_o}{b} = \frac{1.2 * 2.55}{0.30} = 10.2$$

$$\delta = \frac{(\lambda_b)^2 * t}{2000} = \frac{13.2^2 * 0.65}{2000} = 0.056 \; m$$

$$M_{add.} = P * \delta = 283.7 * 0.056 = 15.88 \; kN.m$$

$$e = \frac{M}{P} = \frac{15.88}{283.7} = 0.056 \; m \quad \therefore \frac{e}{t} = \frac{0.056}{0.65} = 0.086 < 0.5 \xrightarrow{use} I.D.$$

$$\zeta = \frac{0.65 - 0.1}{0.65} = 0.8 \xrightarrow{use} \text{ECCS Page 4–24}$$

$$\left.\begin{aligned} \frac{P_U}{F_{cu}\, b\, t} &= \frac{283.7 * 10^3}{25 * 300 * 650} = 0.058 \\ \frac{M_U}{F_{cu}\, b\, t^2} &= \frac{15.88 * 10^6}{25 * 300 * 650^2} = 0.0050 \end{aligned}\right\} \rho < 1.0 \xrightarrow{Take} \rho = 1.0$$

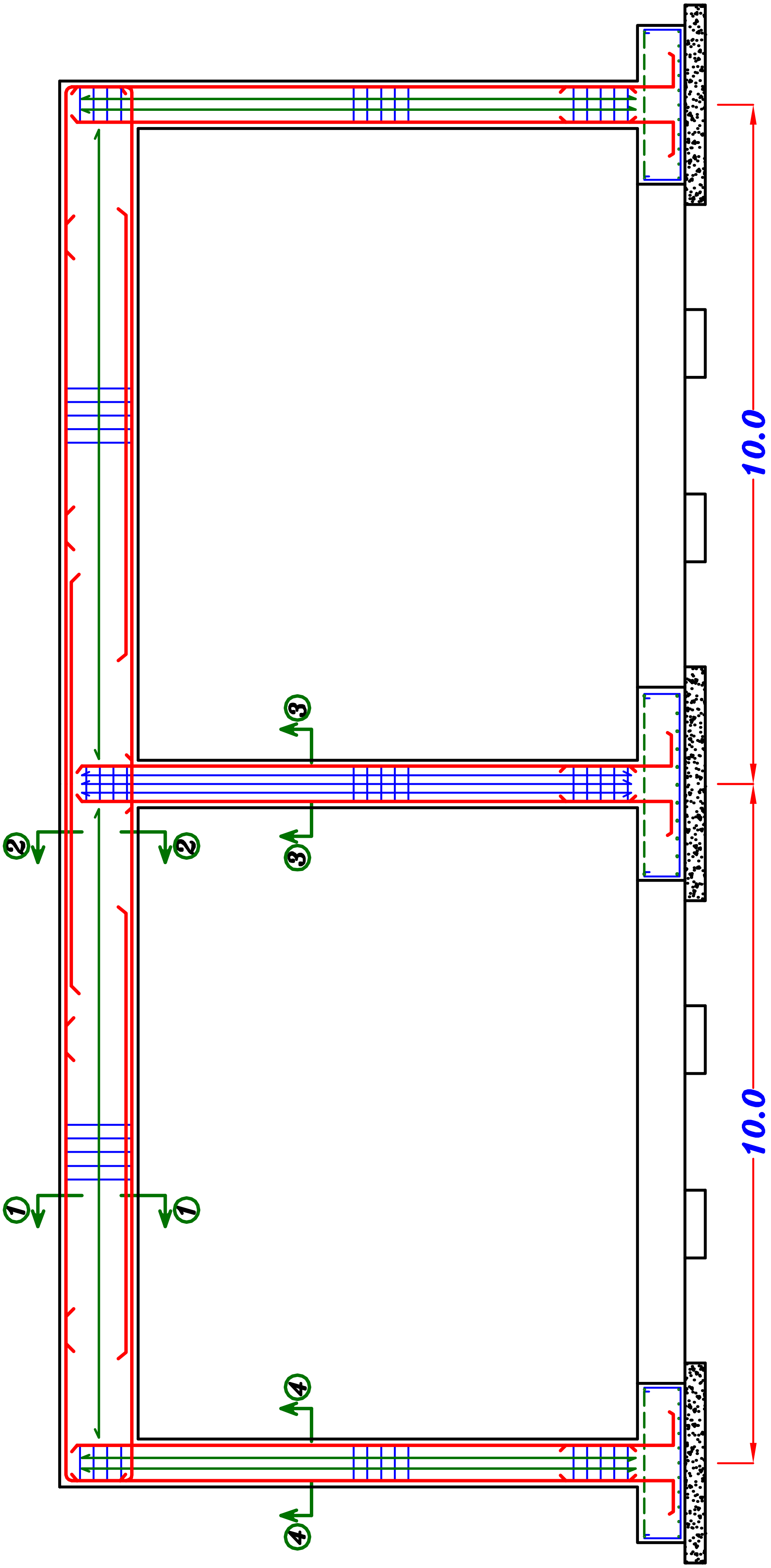
$$A_s = A_s` = \mu * b * t = \rho * F_{cu} * 10^{-4} * b * t = 1.0 * 25 * 10^{-4} * 300 * 650 = 487.5 \; mm^2$$

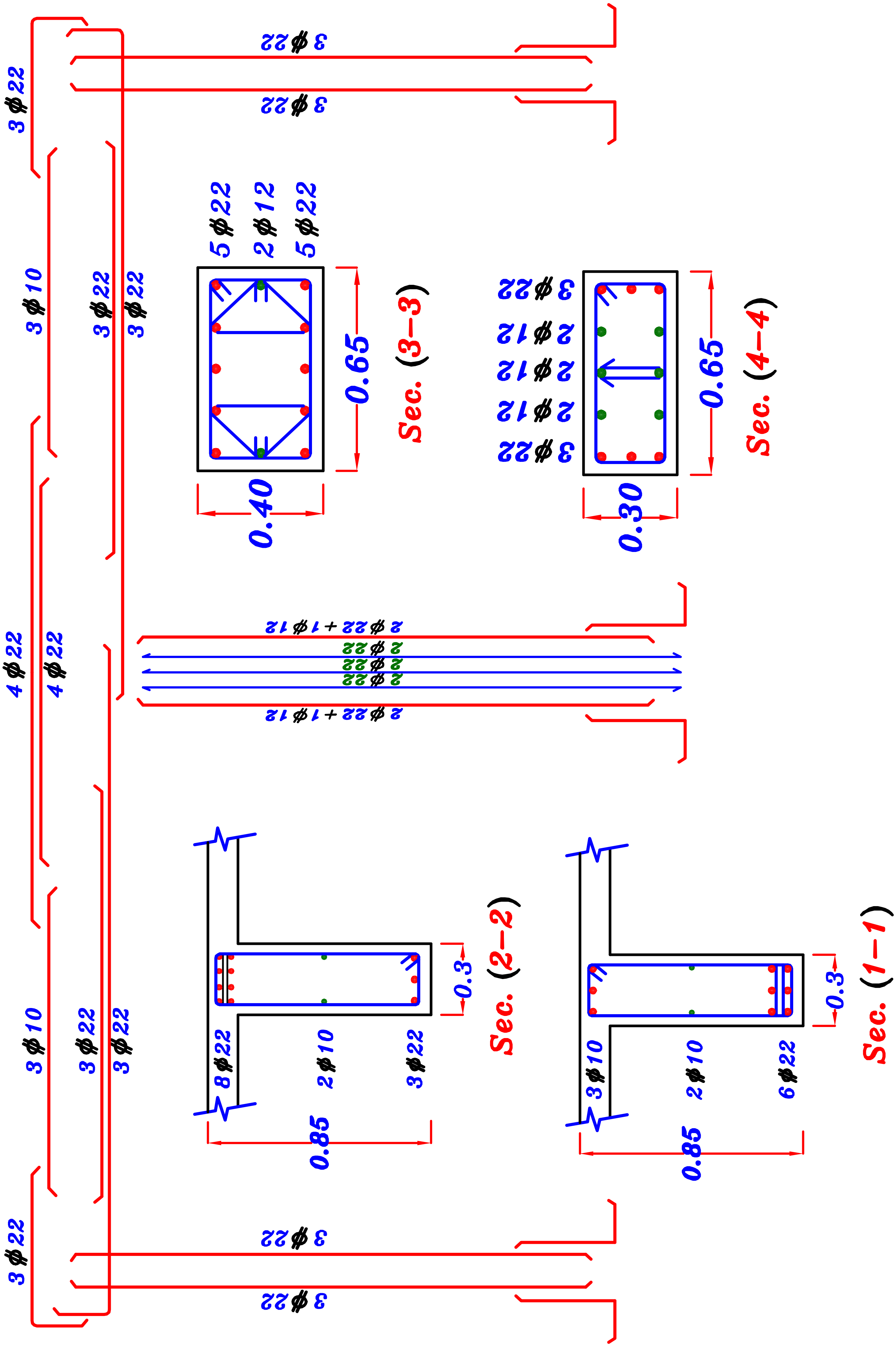
$$A_{s\,total} = A_s + A_s` = 975 \quad mm^2$$

$$A_{s_{min}} = \frac{0.25 + 0.052\, \lambda_{max}}{100} * b * t$$

$$= \frac{0.25 + 0.052\,(13.2)}{100} * 300 * 650 = 1826 \; mm^2 > A_{s\,total}$$

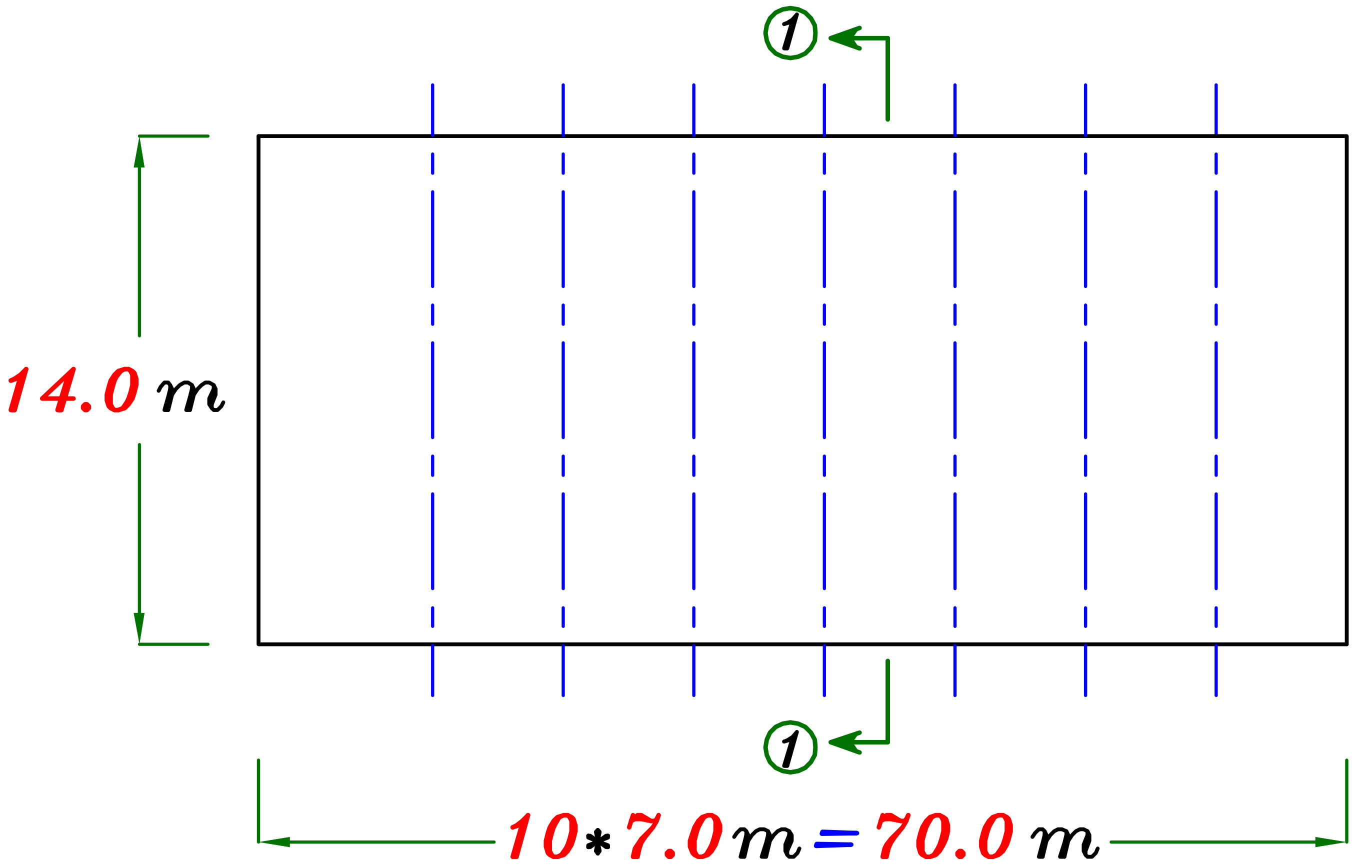
$$A_s = A_s` = \frac{1826}{2} = 913 \; mm^2 \qquad 3 \phi 22$$

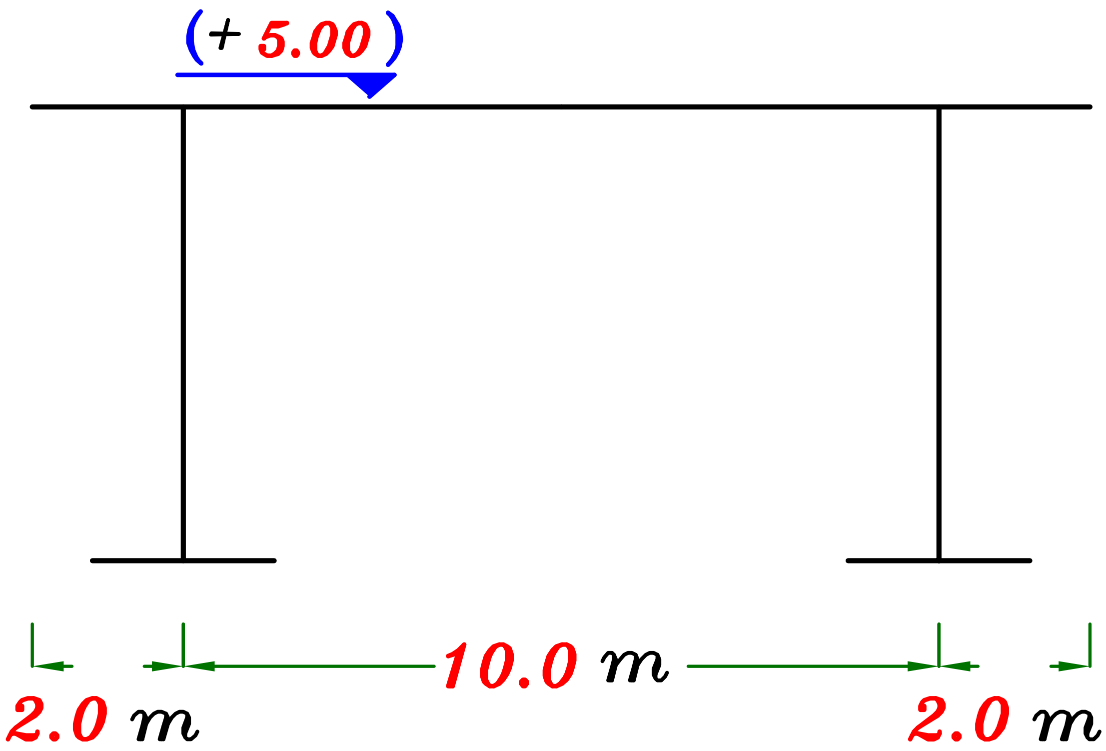

10.0
10.0
1
1
2
2
3
3
4
4



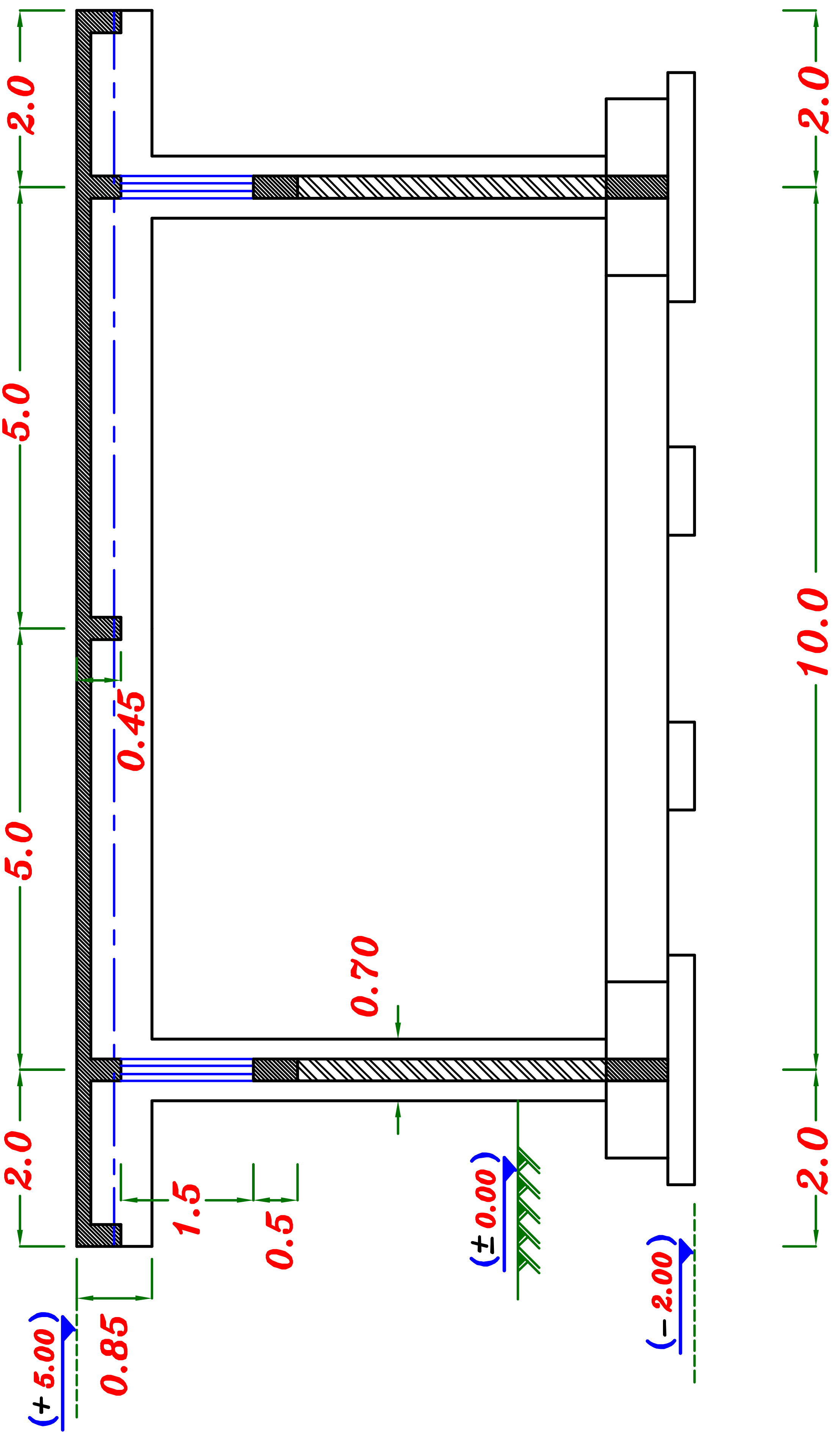
3 ϕ 22
3 ϕ 10
3 ϕ 22
3 ϕ 22
4 ϕ 22
4 ϕ 22
2 ϕ 22 + 1 ϕ 12
2 ϕ 22
5 ϕ 22
2 ϕ 12
5 ϕ 22
0.65
0.40
Sec. (3–3)
3 ϕ 22
2 ϕ 12
2 ϕ 12
2 ϕ 12
3 ϕ 22
0.65
0.30
Sec. (4–4)
8 ϕ 22
2 ϕ 10
3 ϕ 22
0.3
0.85
Sec. (2–2)
3 ϕ 10
2 ϕ 10
6 ϕ 22
0.3
0.85
Sec. (1–1)

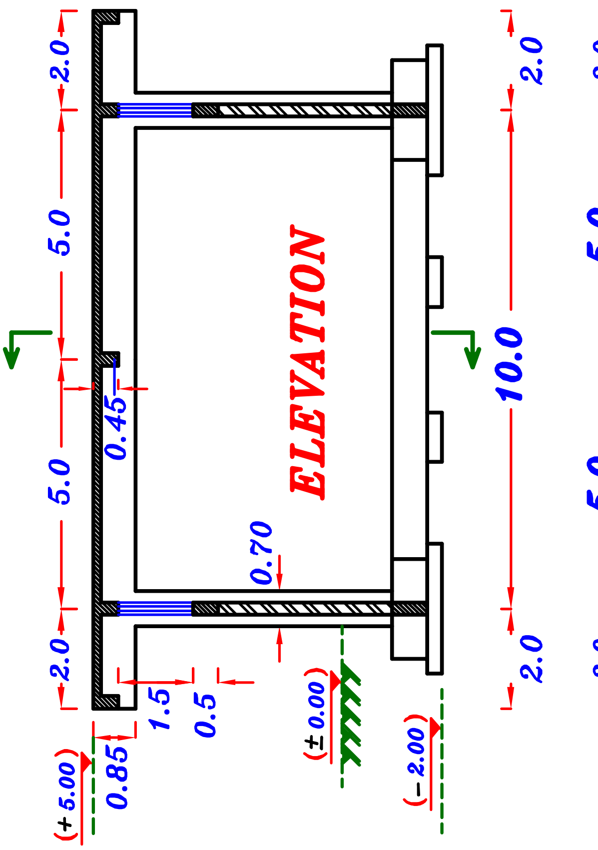
Example.

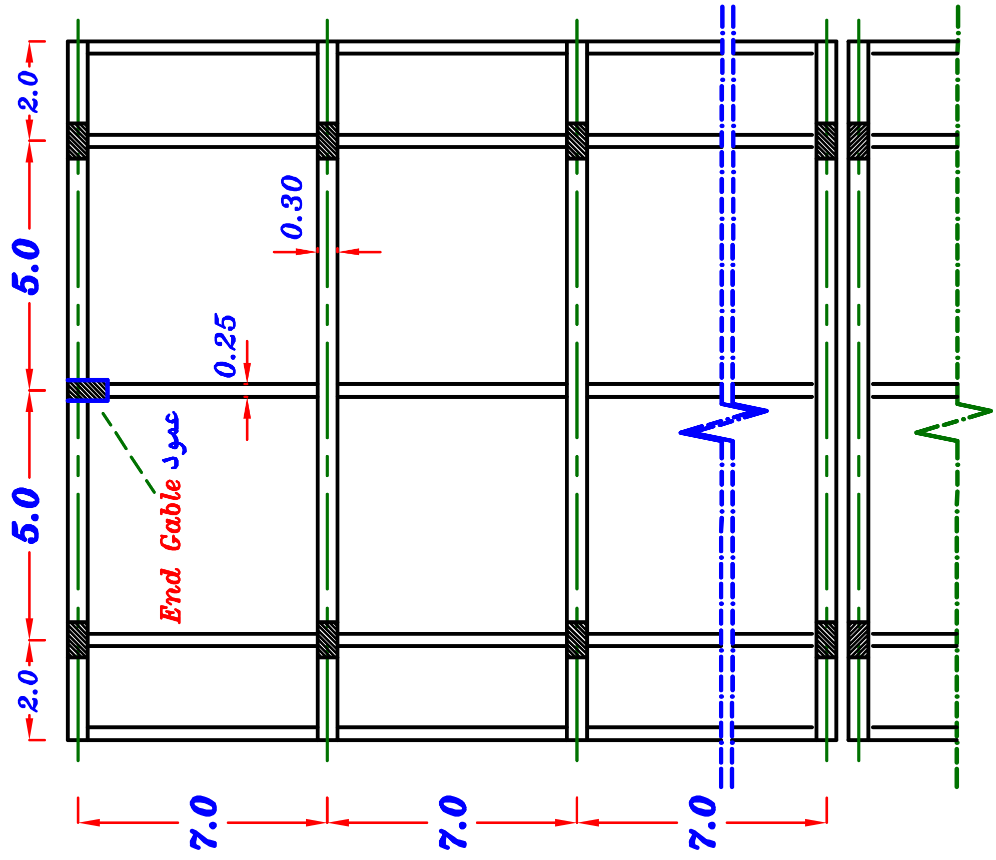




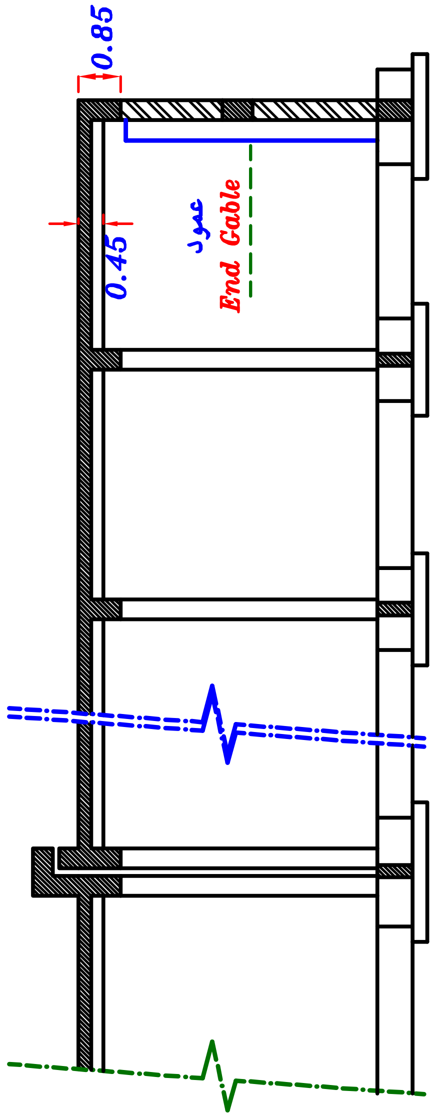
IF the slab is Solid Slab



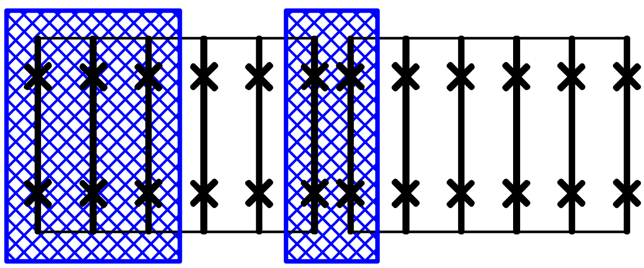




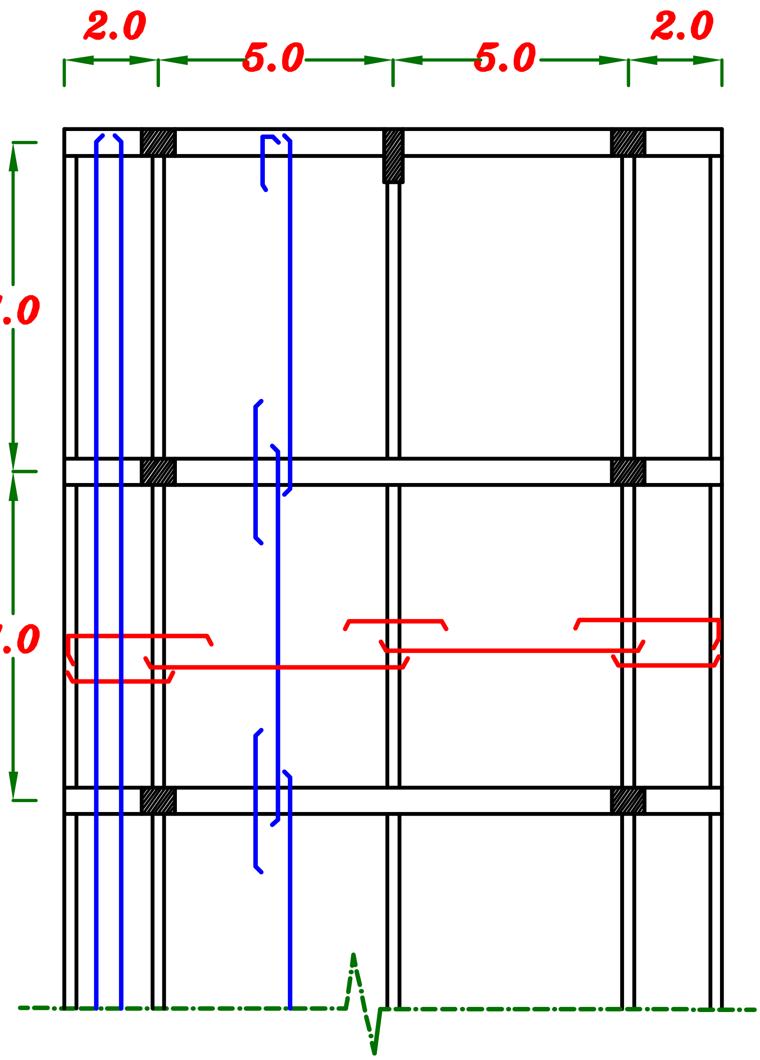
PLAN



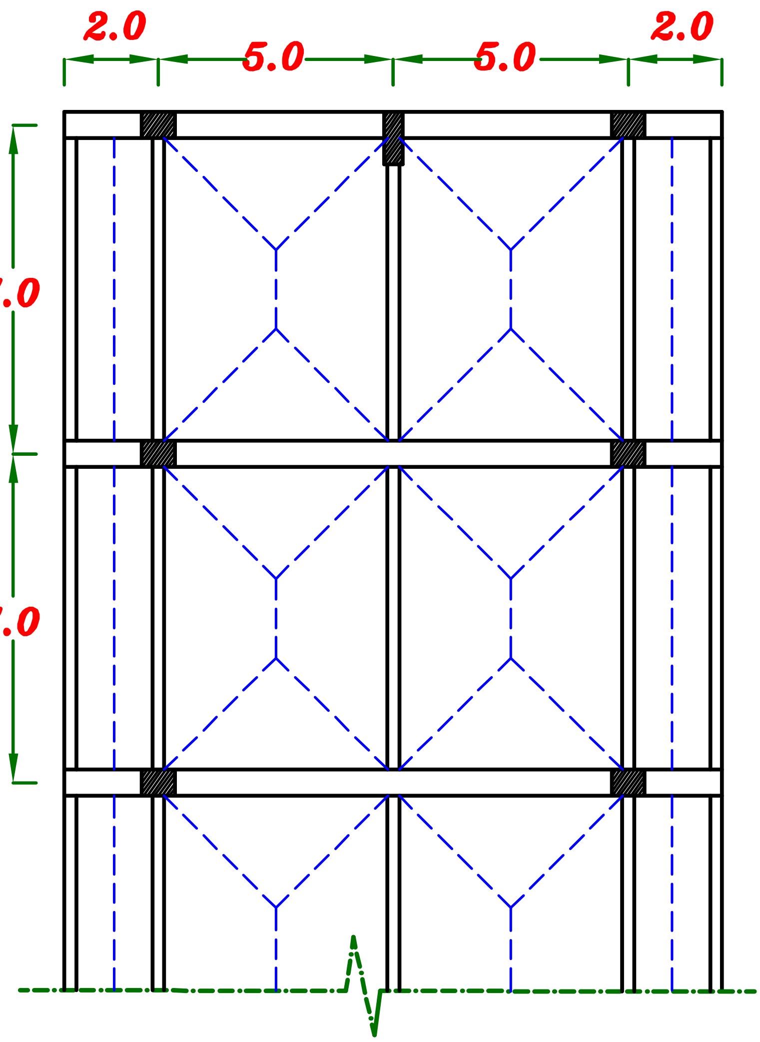
SIDE VIEW



KEY PLAN

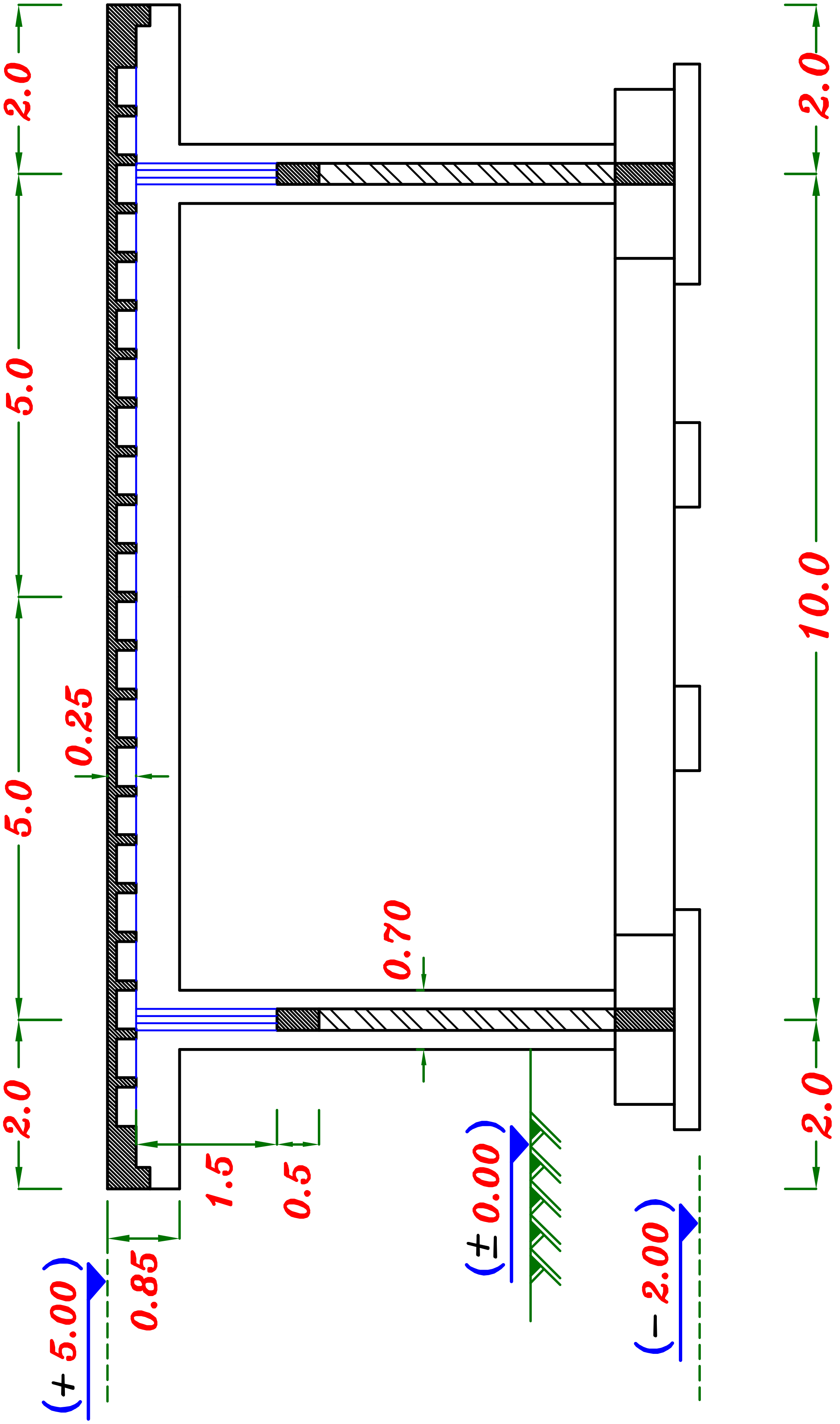


RFT. of slabs

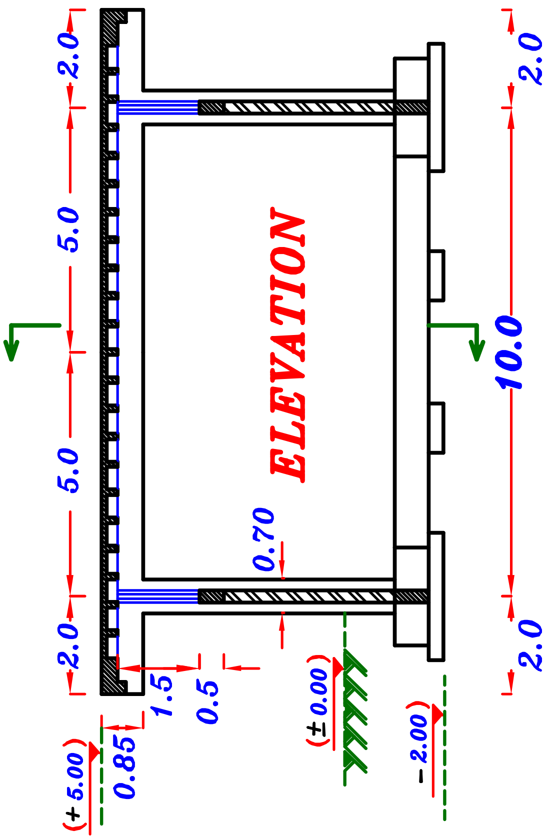


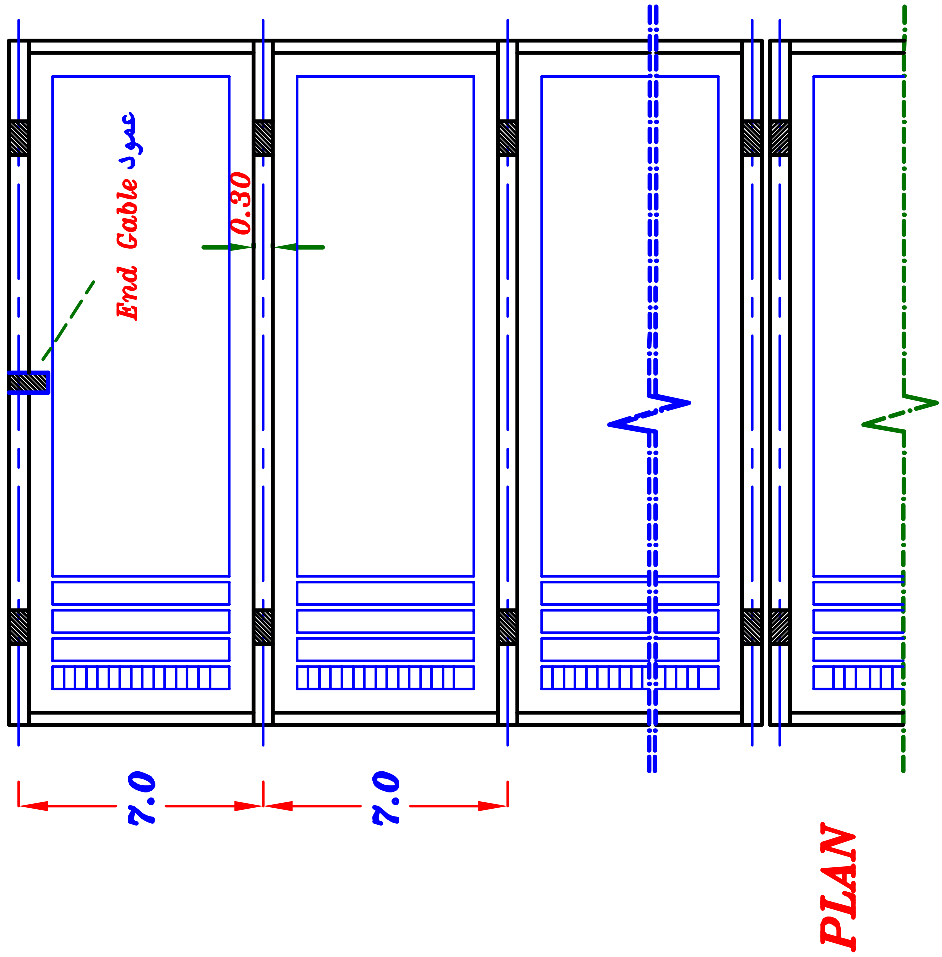
Load Distribution

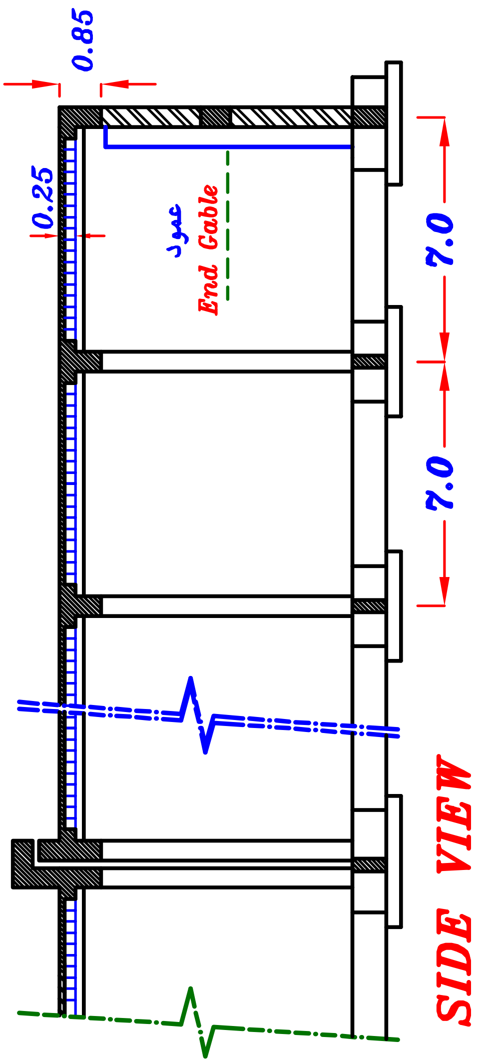
IF the slab is Hollow Blocks.

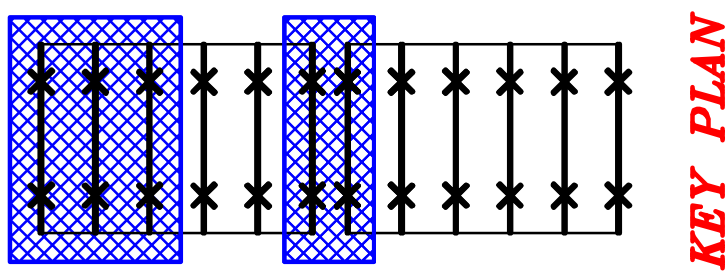


IF the slab is Hollow Blocks.

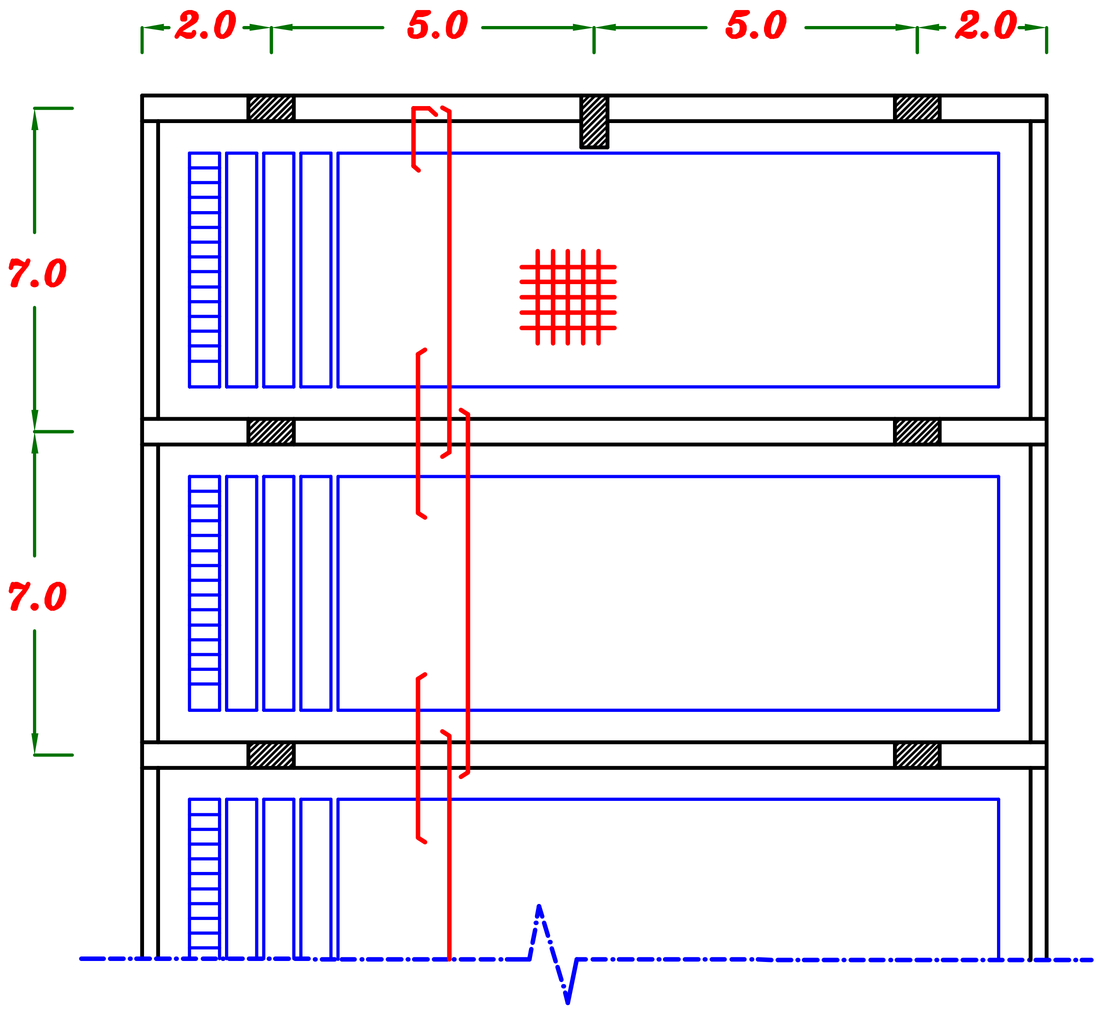




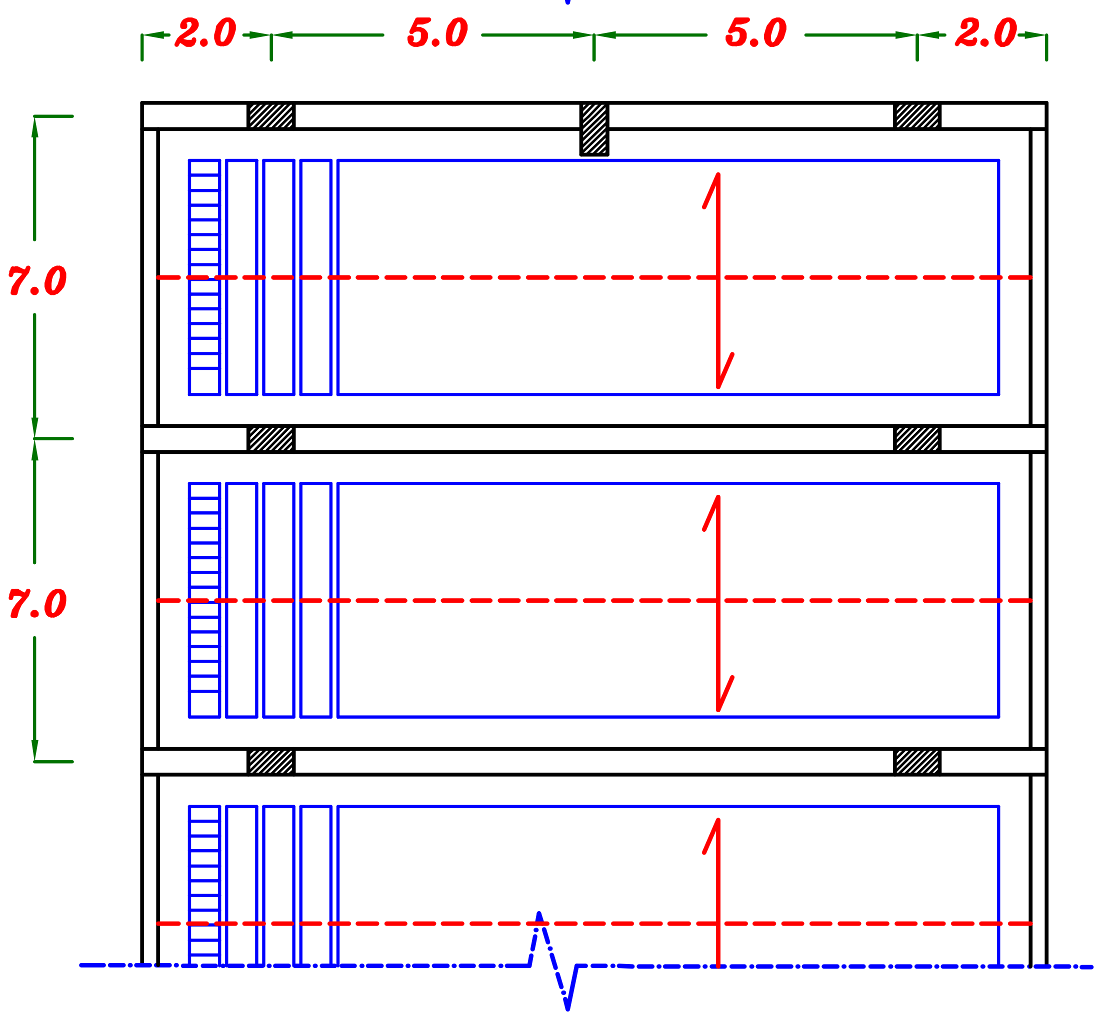




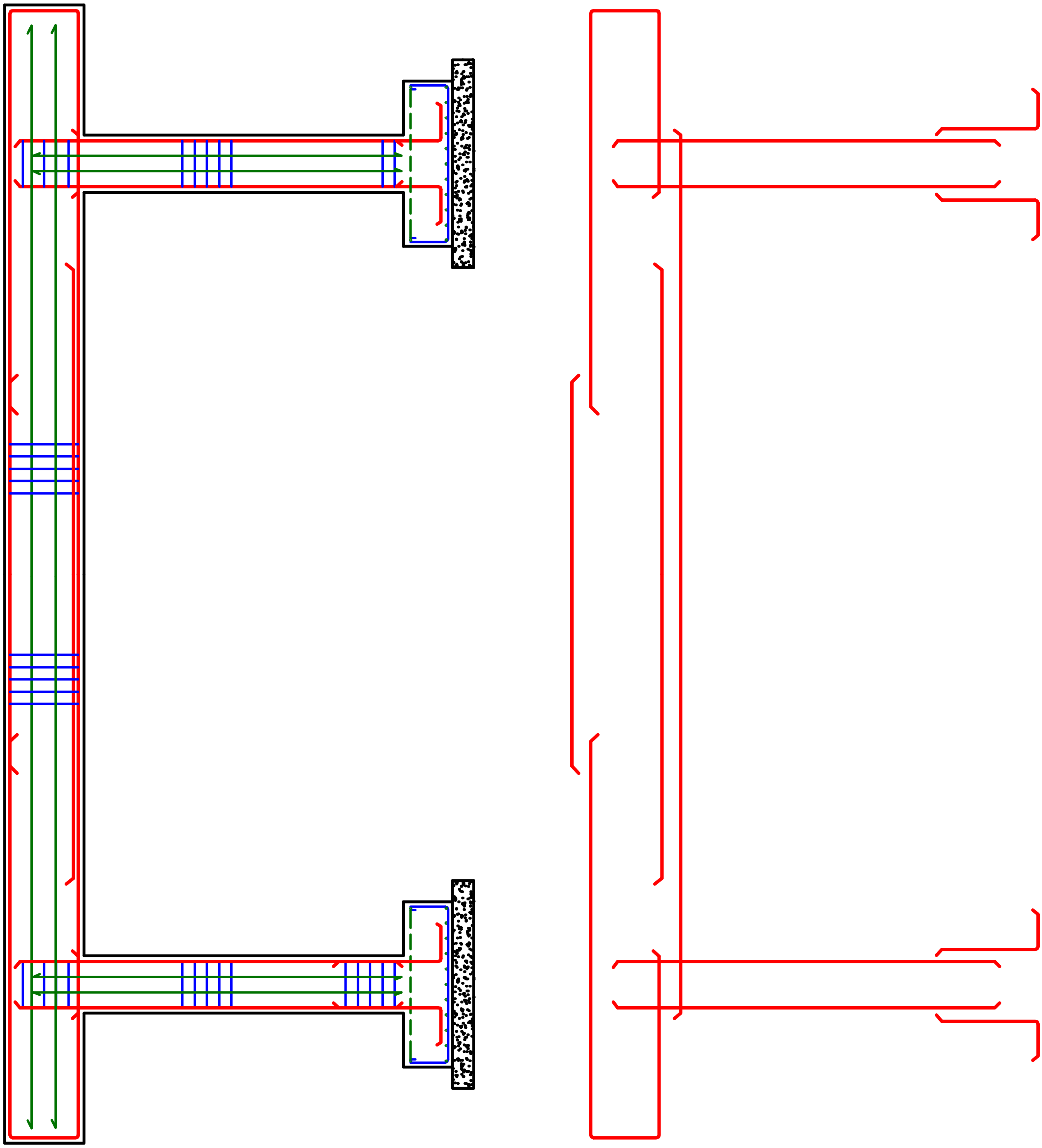
IF the slab is Hollow Blocks.



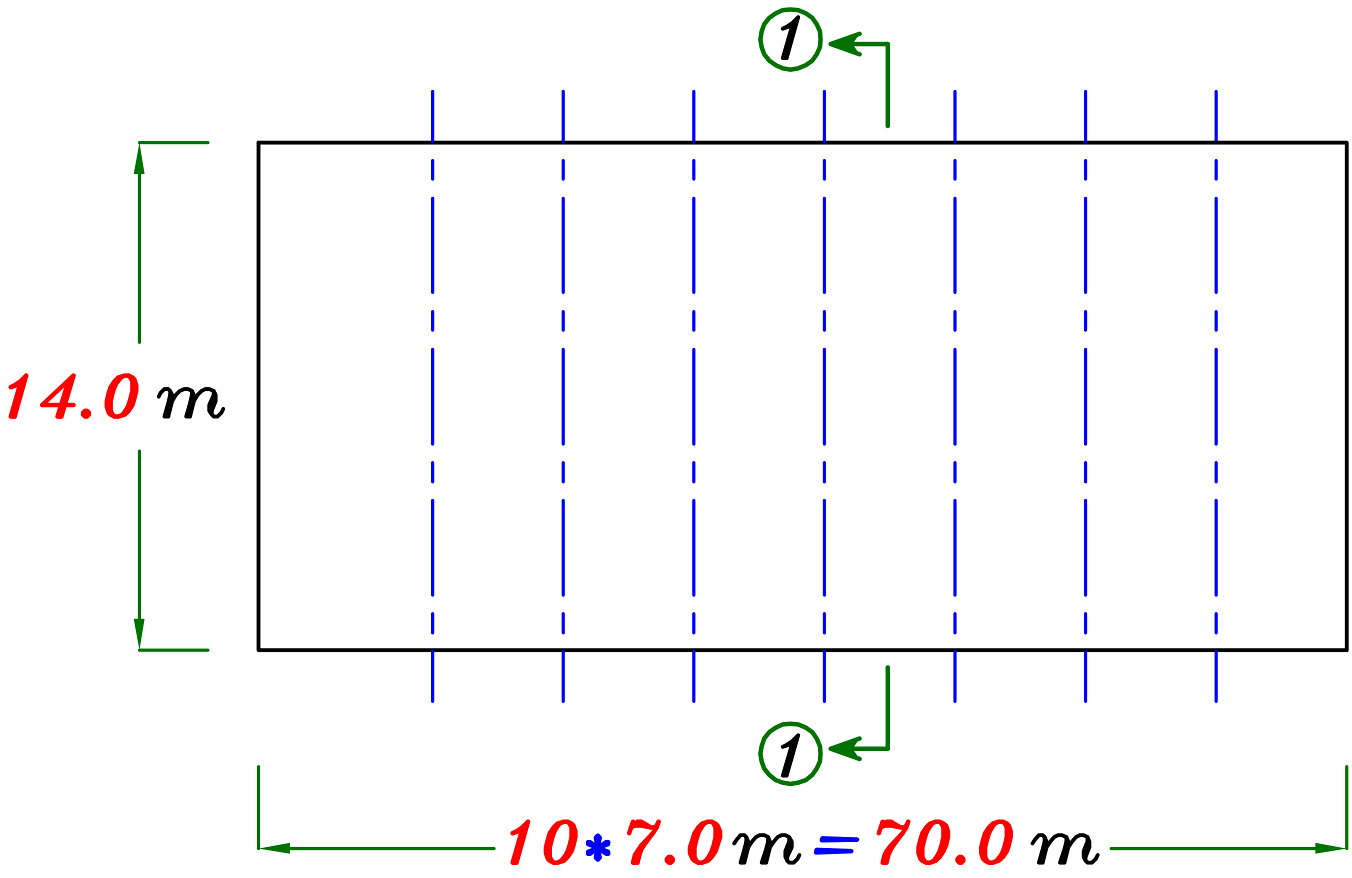
RFT. of slabs

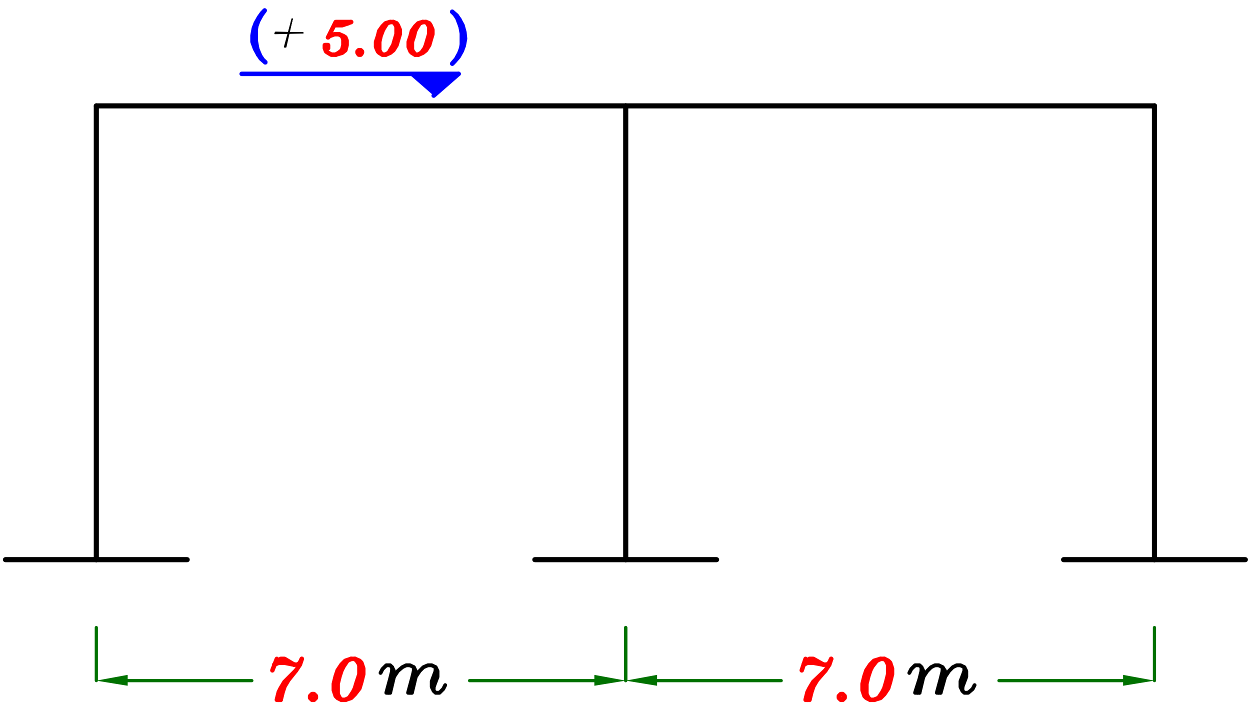


Load Distribution

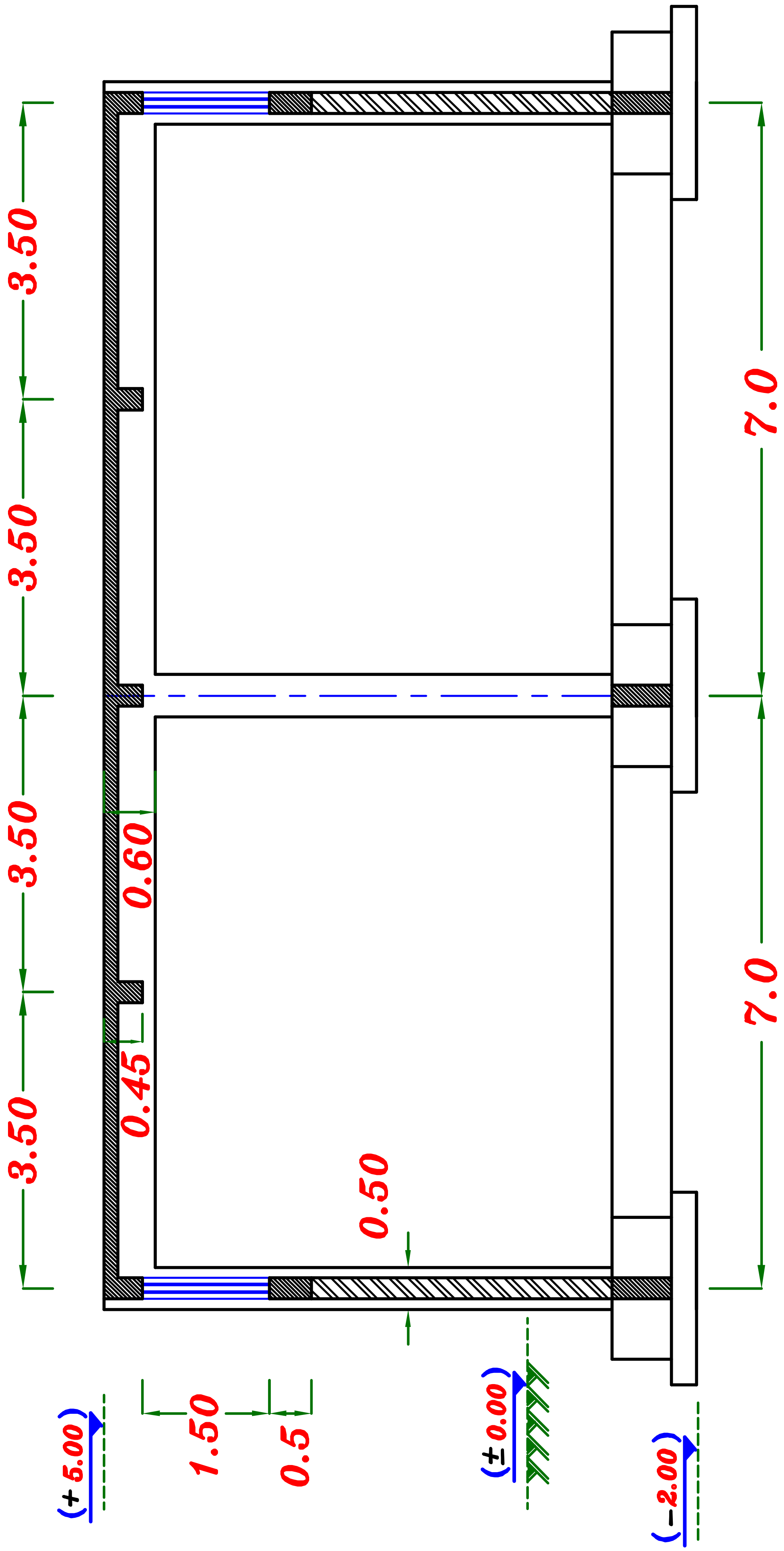


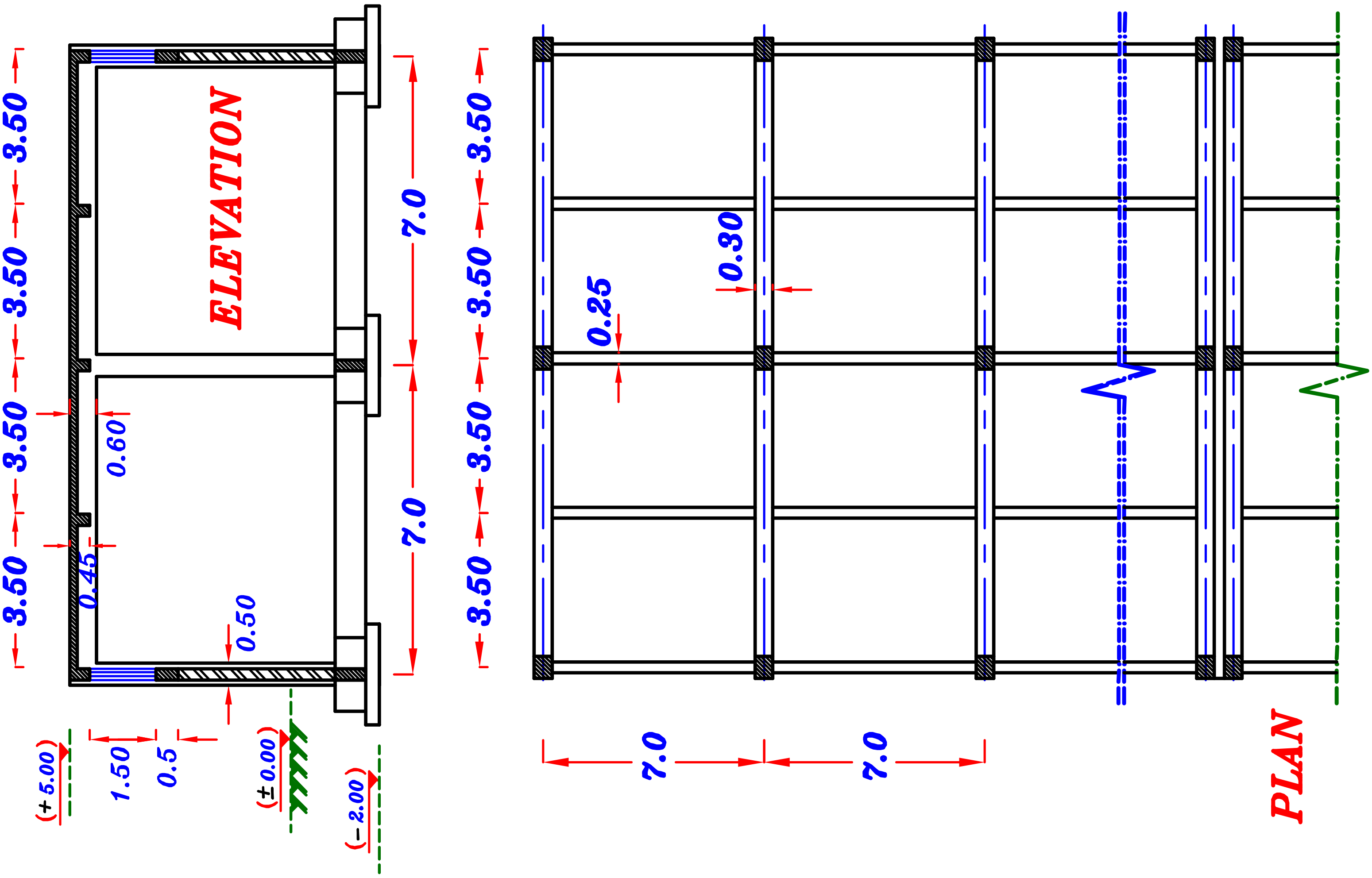
Example.



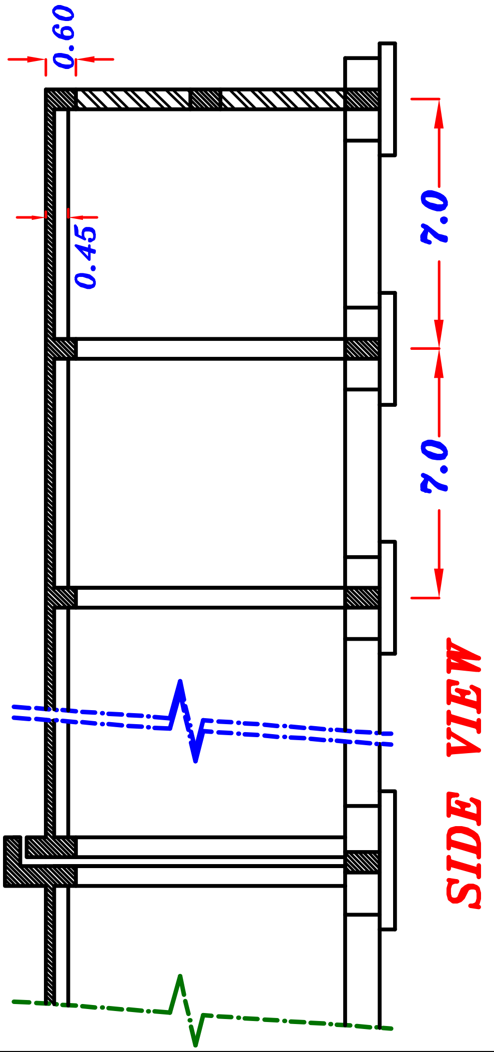


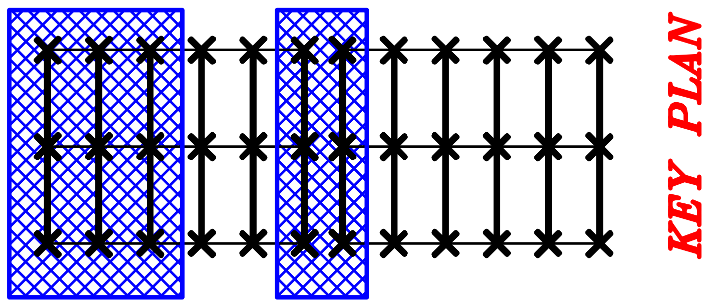
IF the slab is Solid Slab



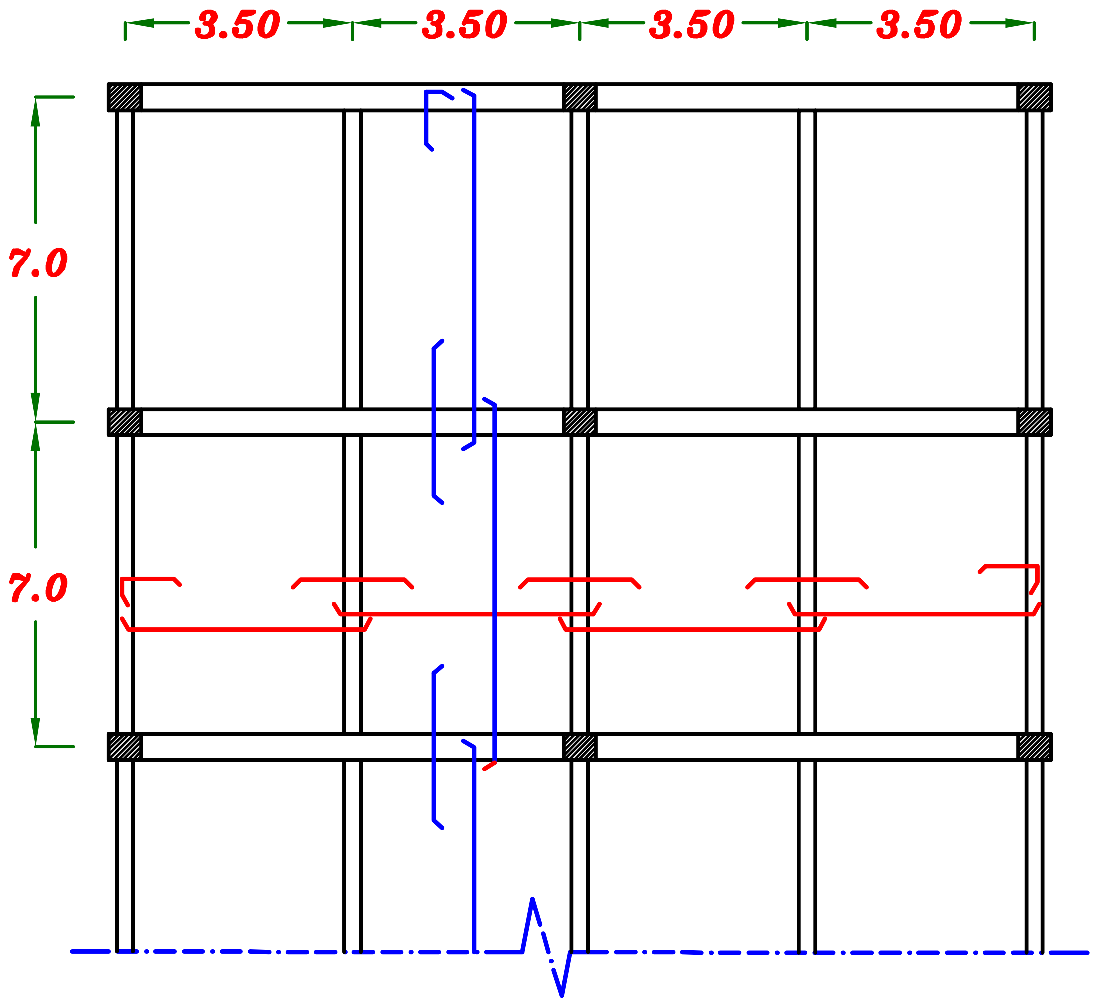


IF the slab is Solid Slab

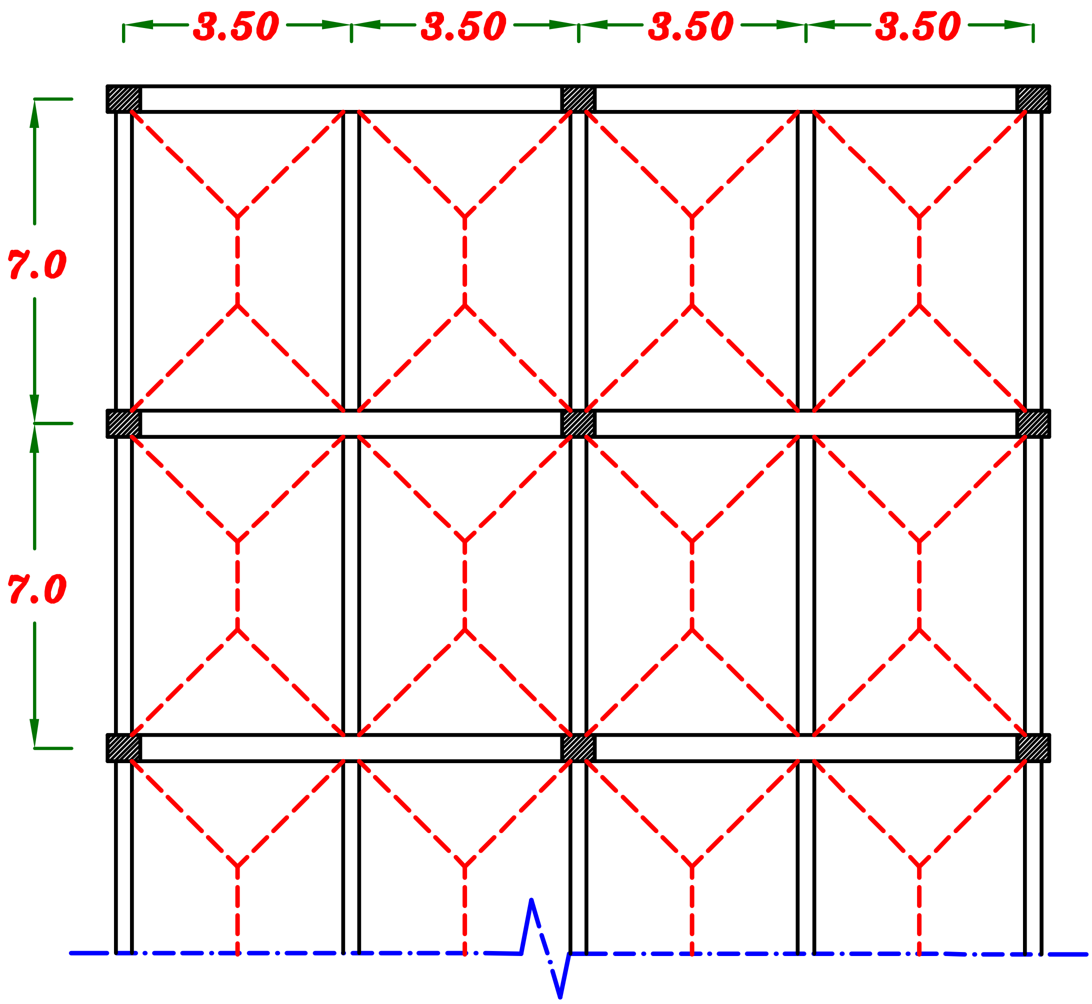




IF the slab is Solid Slab

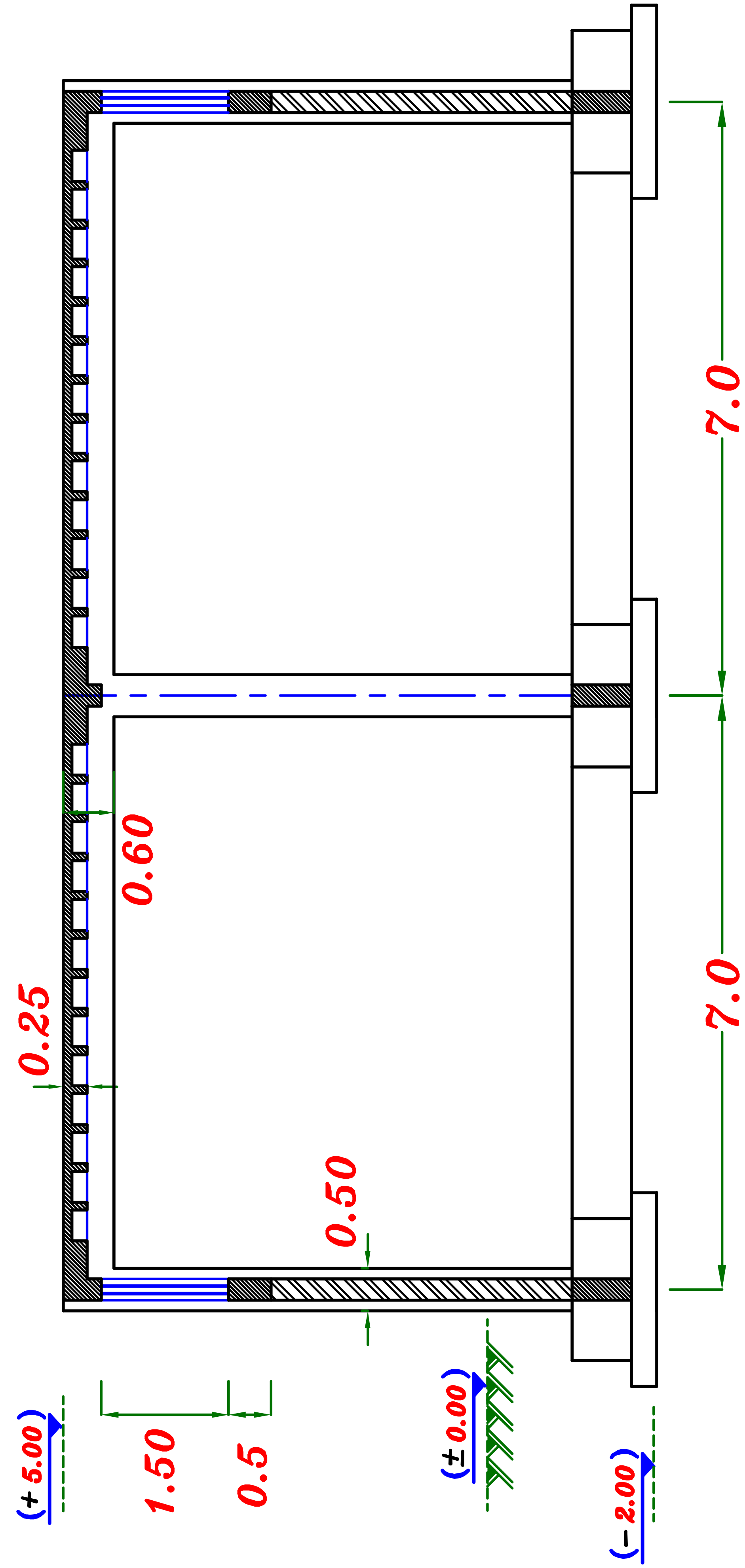


RFT.
of slabs

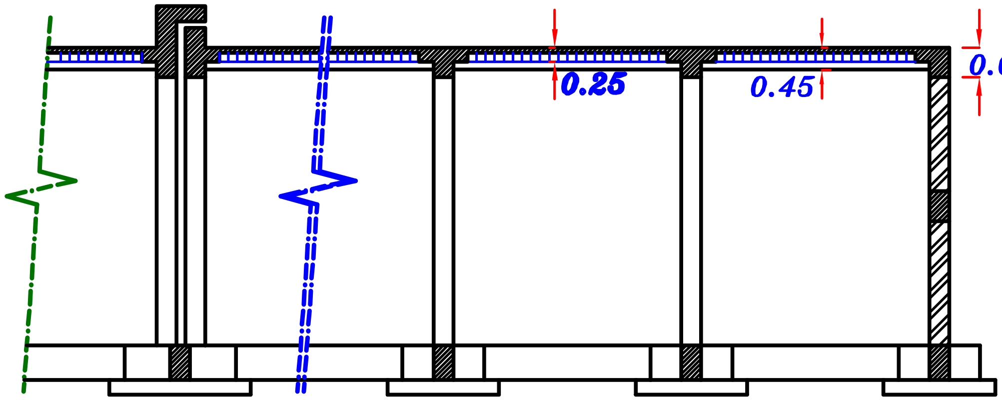


Load
Distribution

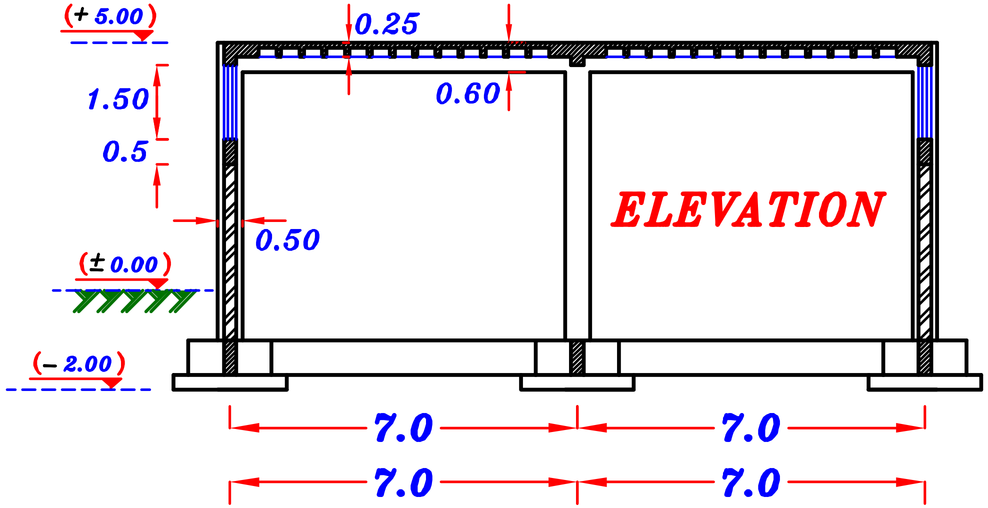
IF the slab is Hollow Blocks.



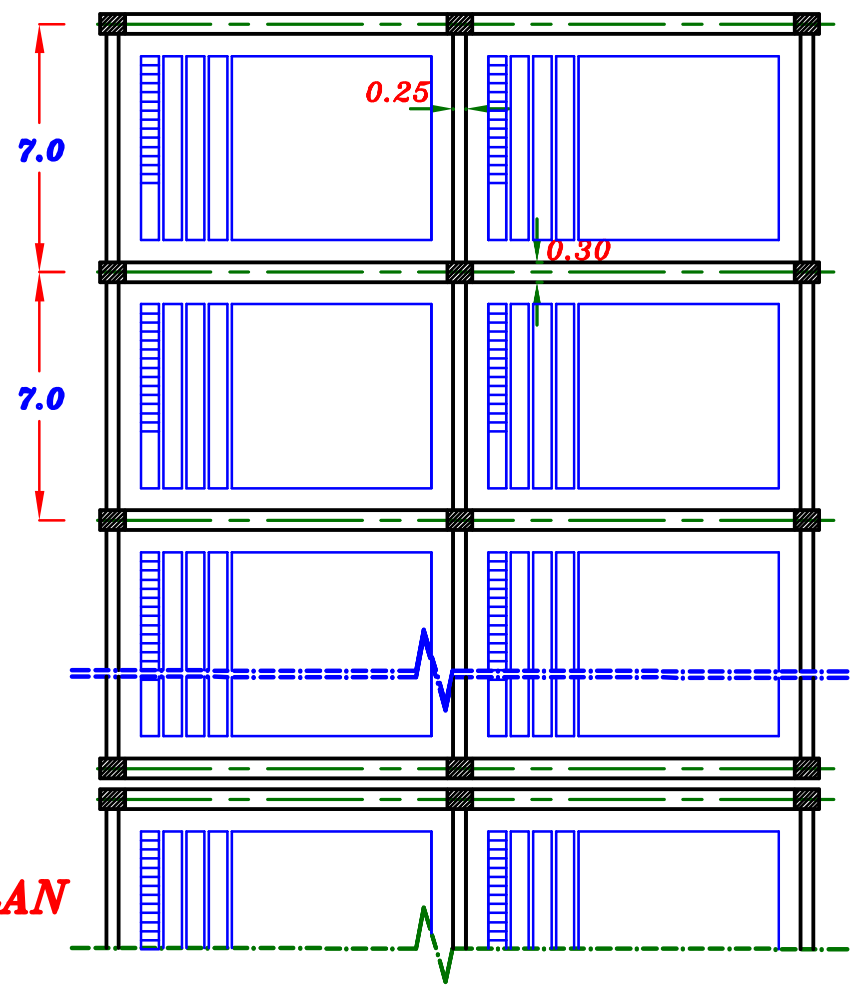
IF the slab is Hollow Blocks.



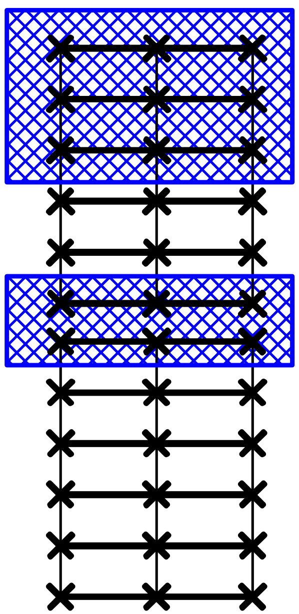
SIDE VIEW



ELEVATION

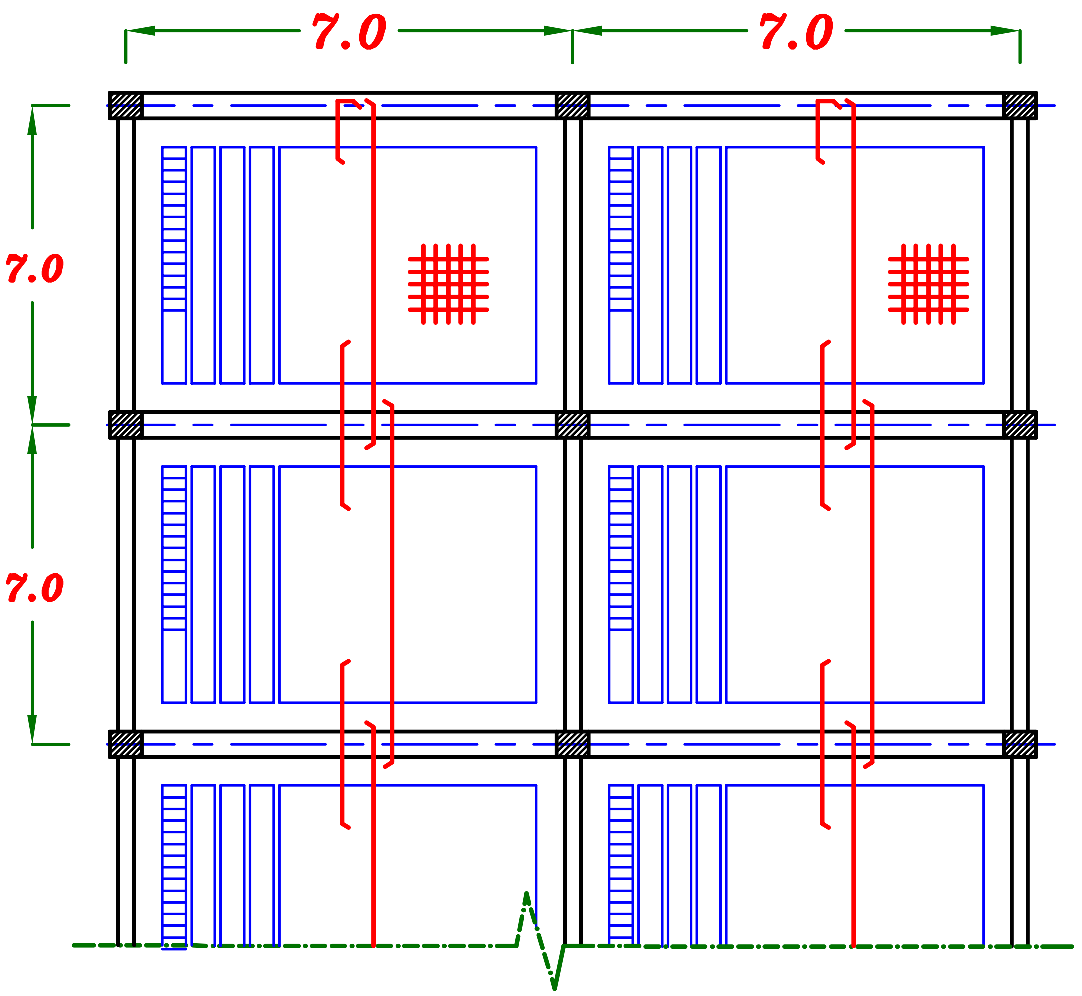


PLAN

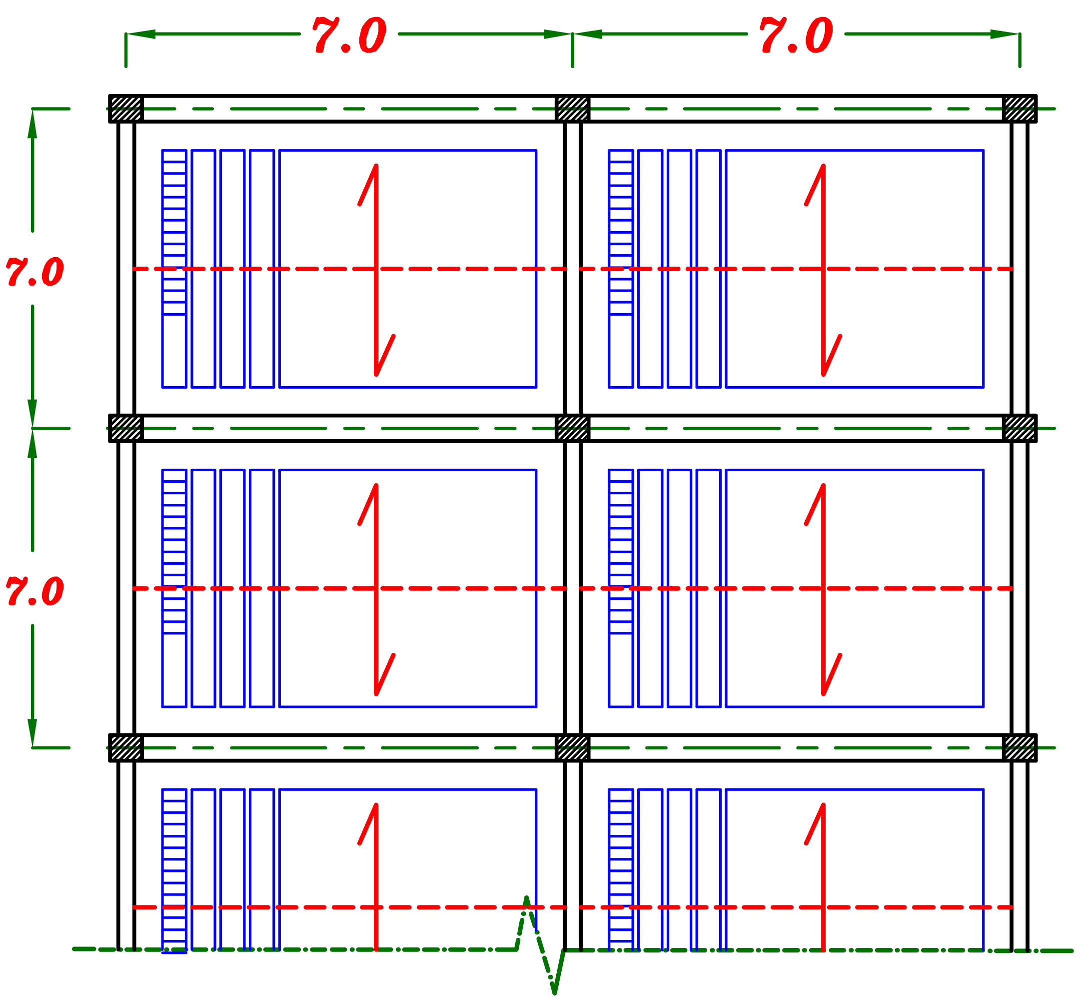


KEY PLAN

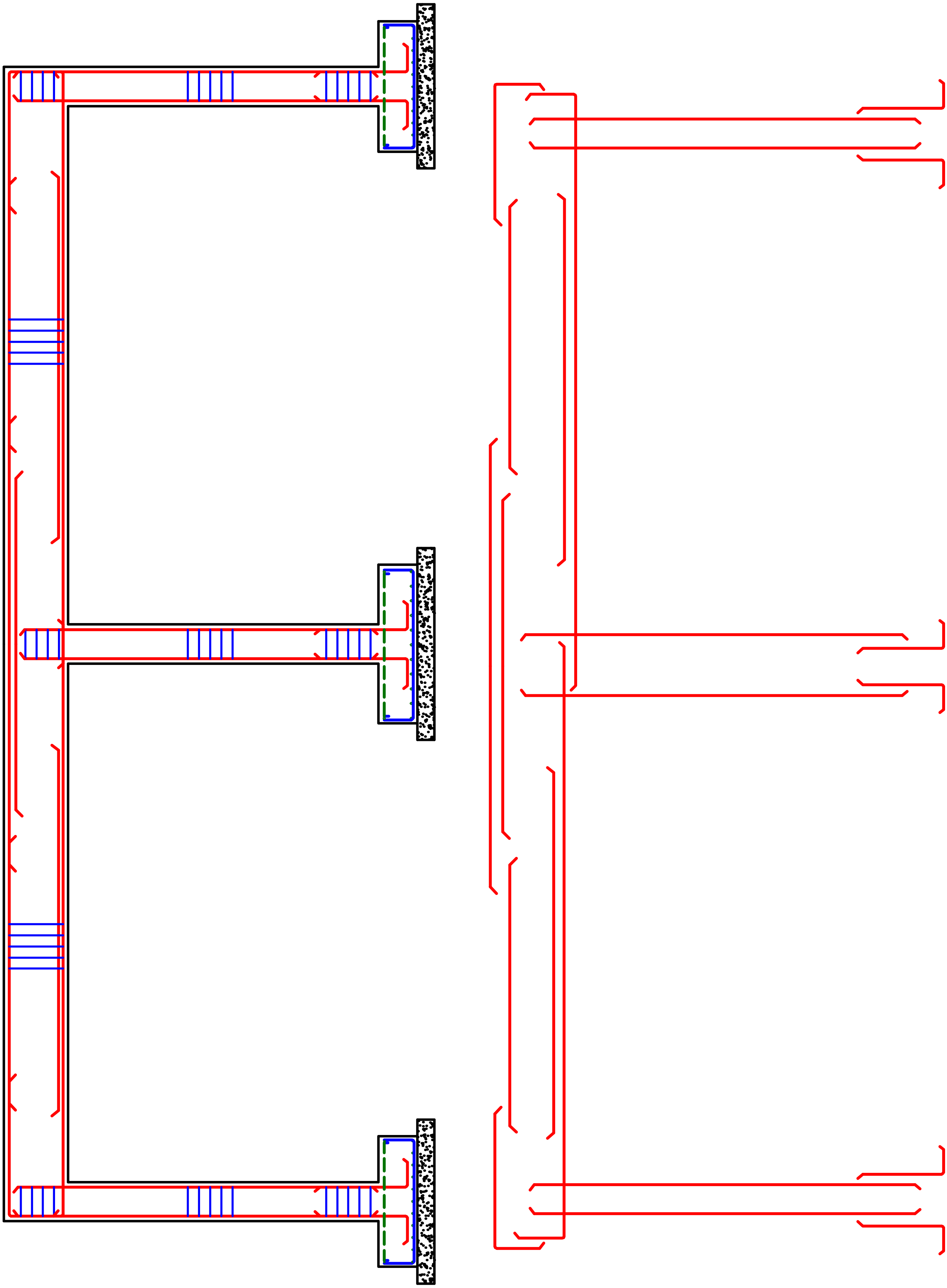
IF the slab is Hollow Blocks.



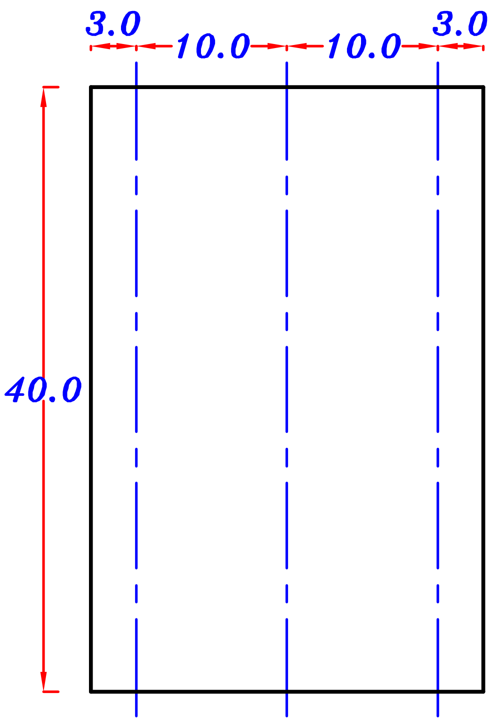
RFT. of slabs

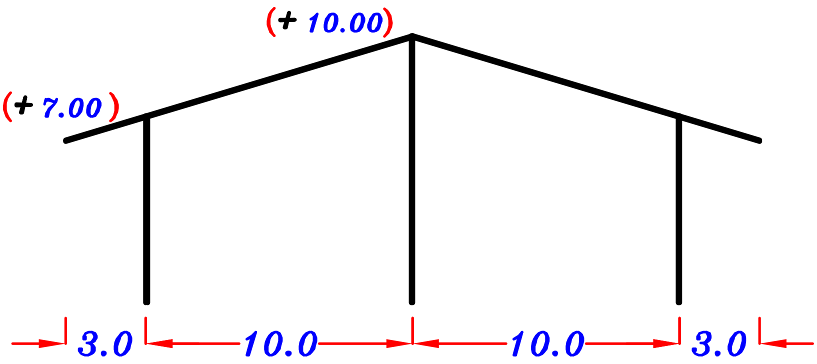


Load Distribution



Example.





$F_{cu.} = 25$ N\mm^2 , $F_y = 360$ N\mm^2

L.L. = 1.5 kN\m^2 , F.C. = 2.0 kN\m^2

Foundation Level. = – 2.0 m

Req.

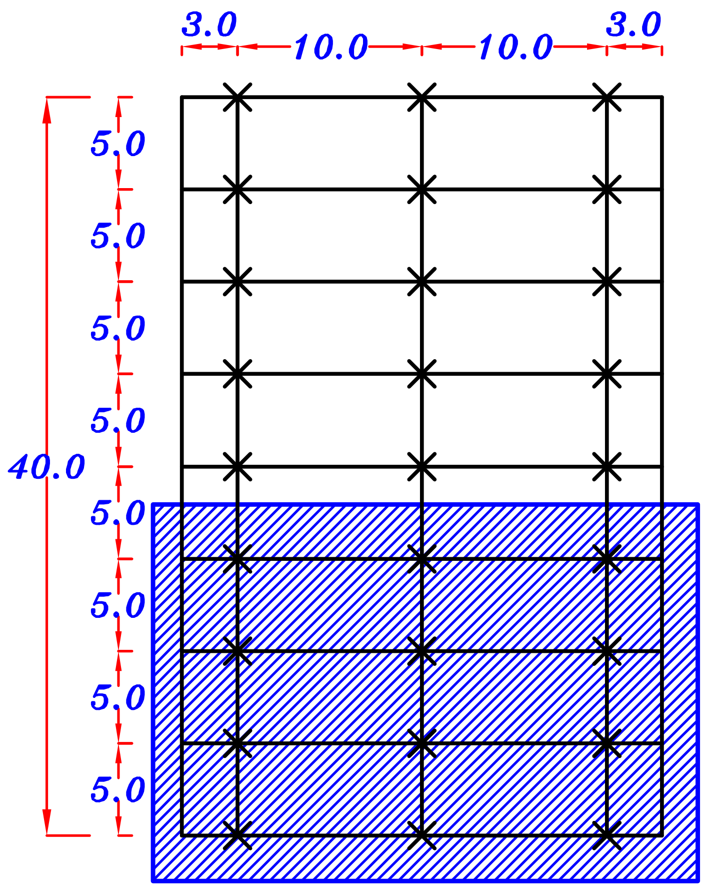
1 – Draw concrete Dimensions in plan & elevation.

2 – Show the statical system For the main system.

3 – Design the slabs & Draw its RFT. in plan.

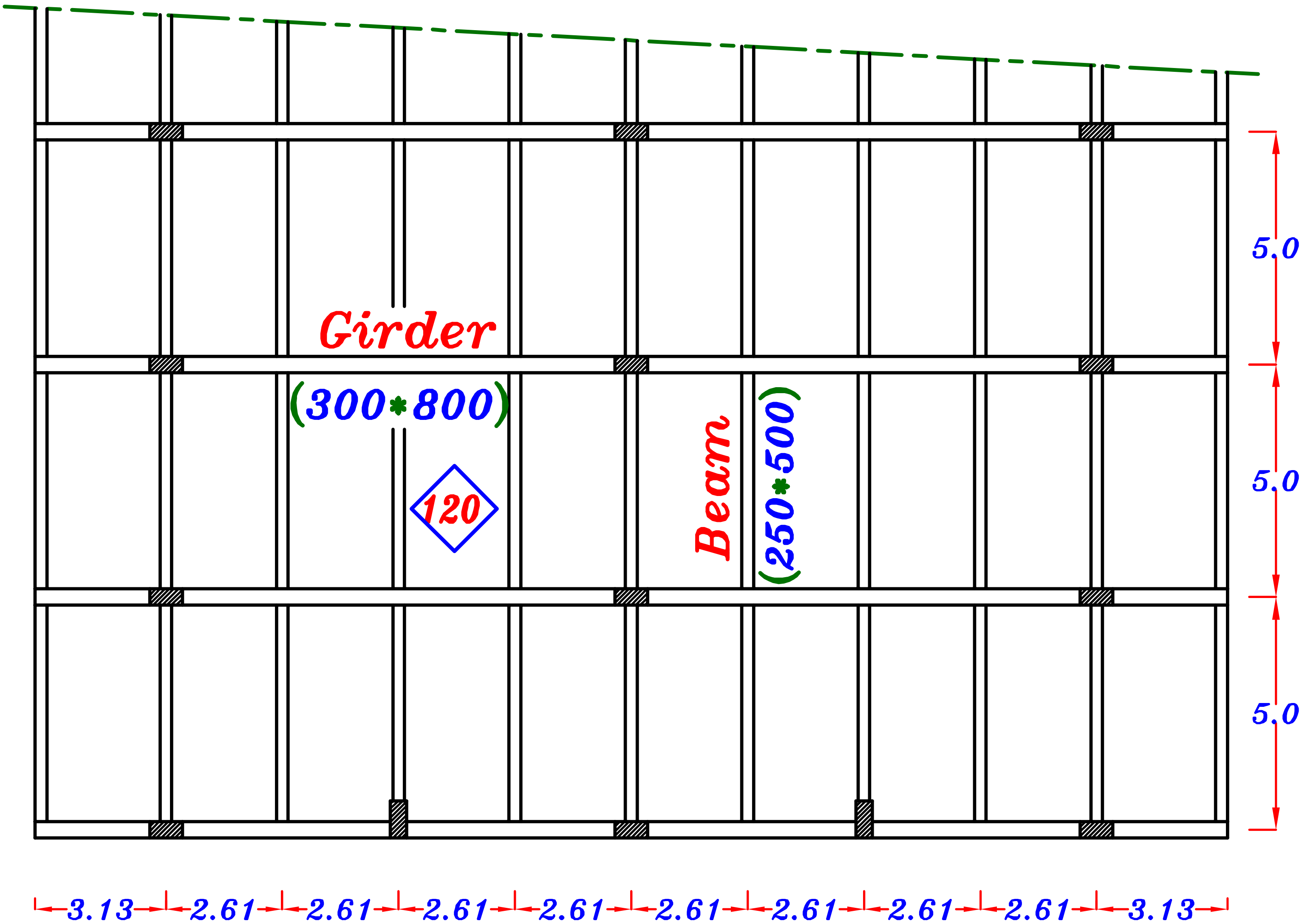
4 – Design the secondary beams and draw its RFT. in elevation & Cross-Sec.

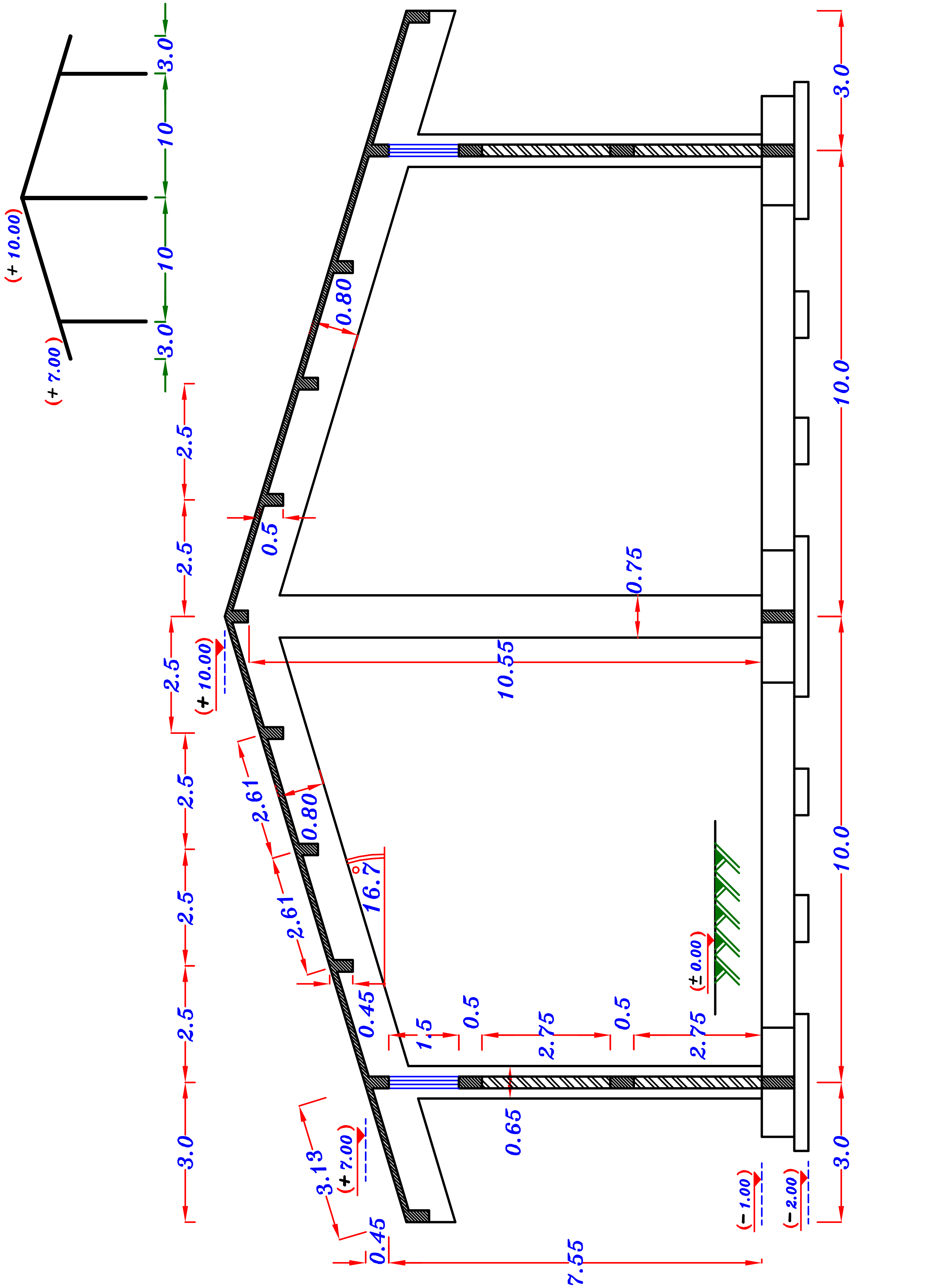
5 – Design the Main system and draw its RFT. in elevation & Cross-Sec.



Key Plan

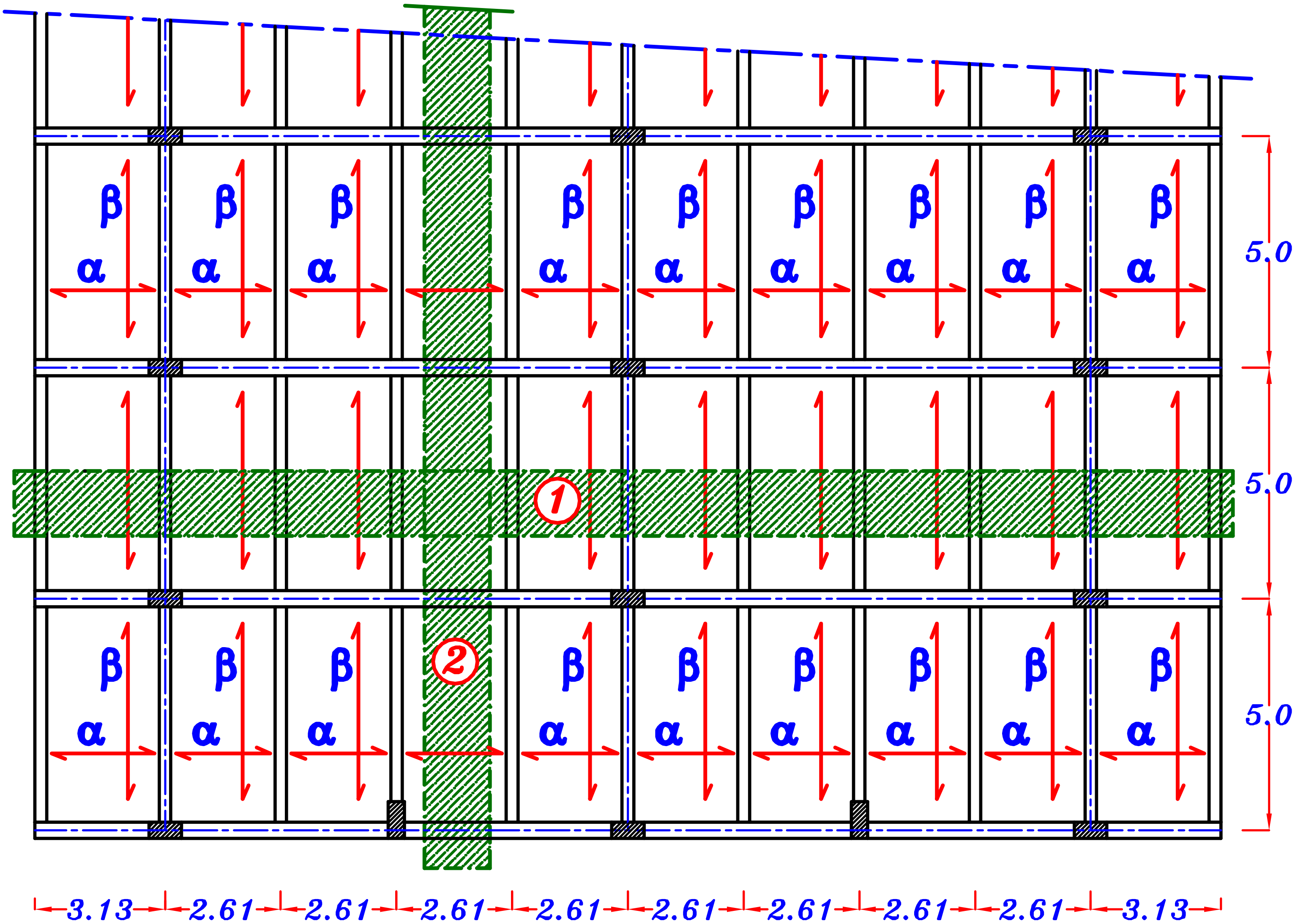
Plan concrete Dimensions.





(+ 10.00)
(+ 7.00)
(± 0.00)
(− 1.00)
(− 2.00)
16.7°
10.55
7.55

Design of slabs.



t_s Two way Slabs

$$t_s = \frac{L_s}{40} = \frac{3130}{40} = 78.2 \text{ mm}$$

$$\boxed{t_s = 120 \text{ mm}}$$

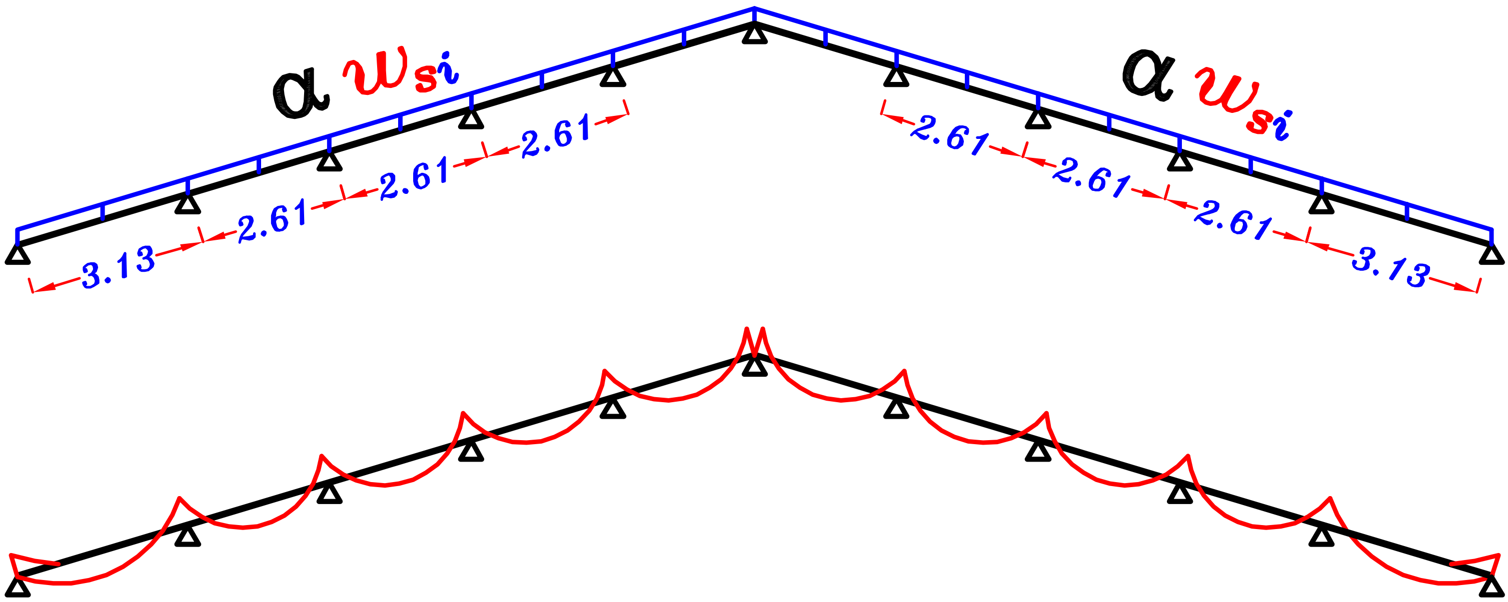
w_s

$$w_{si} = 1.4\,(t_s\,\gamma_c + F.C.) + 1.6\,(L.L.)\,\cos\theta$$

$$w_{si} = 1.4\,(0.12 * 25 + 2.0) + 1.6\,(1.50)\,\cos 16.7^\circ = 9.30 \text{ kN}\backslash m^2$$

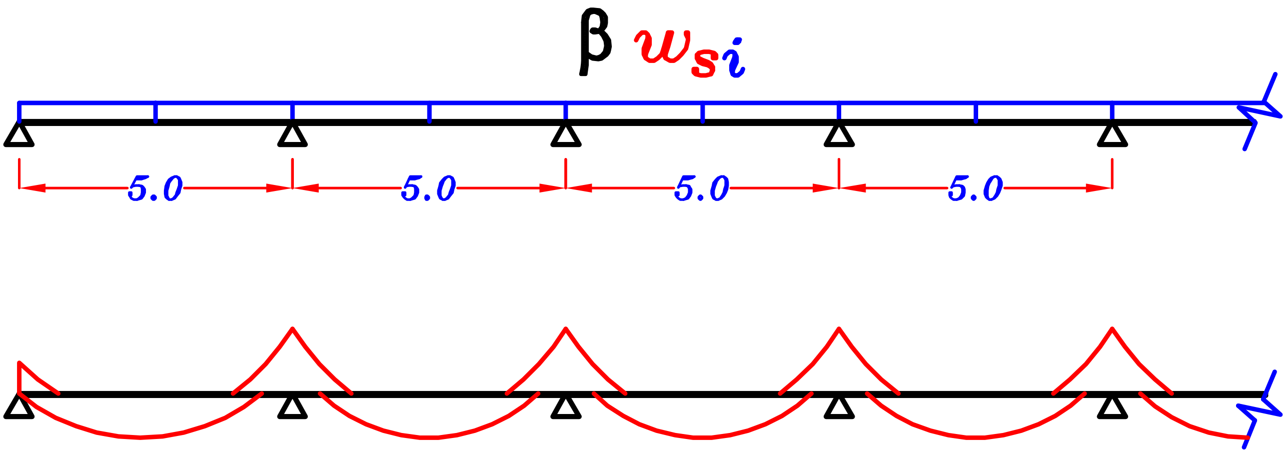
$$\boxed{w_{si} = 9.30 \text{ kN}\backslash m^2}$$

Strip (1)

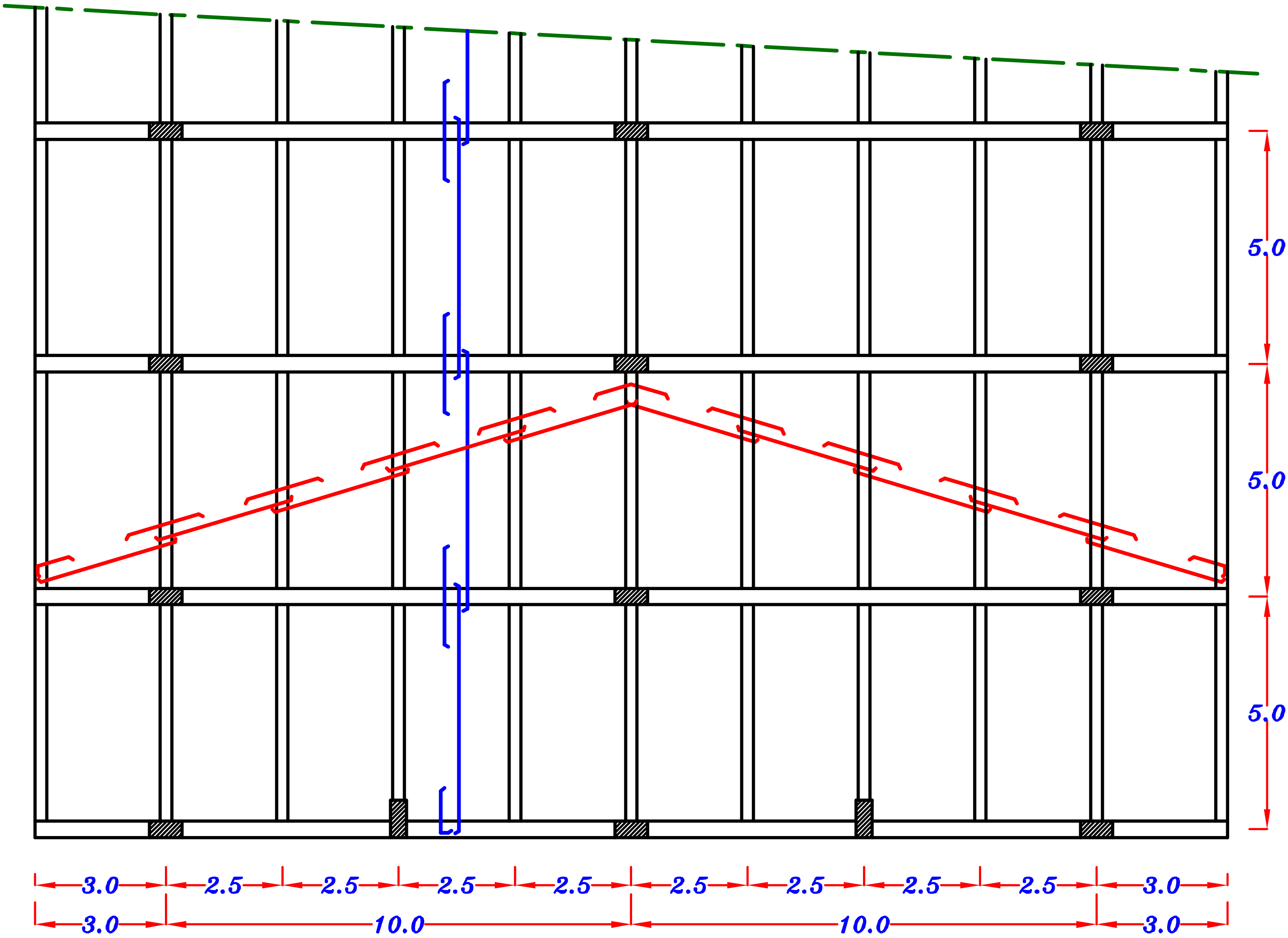


Strip (2)

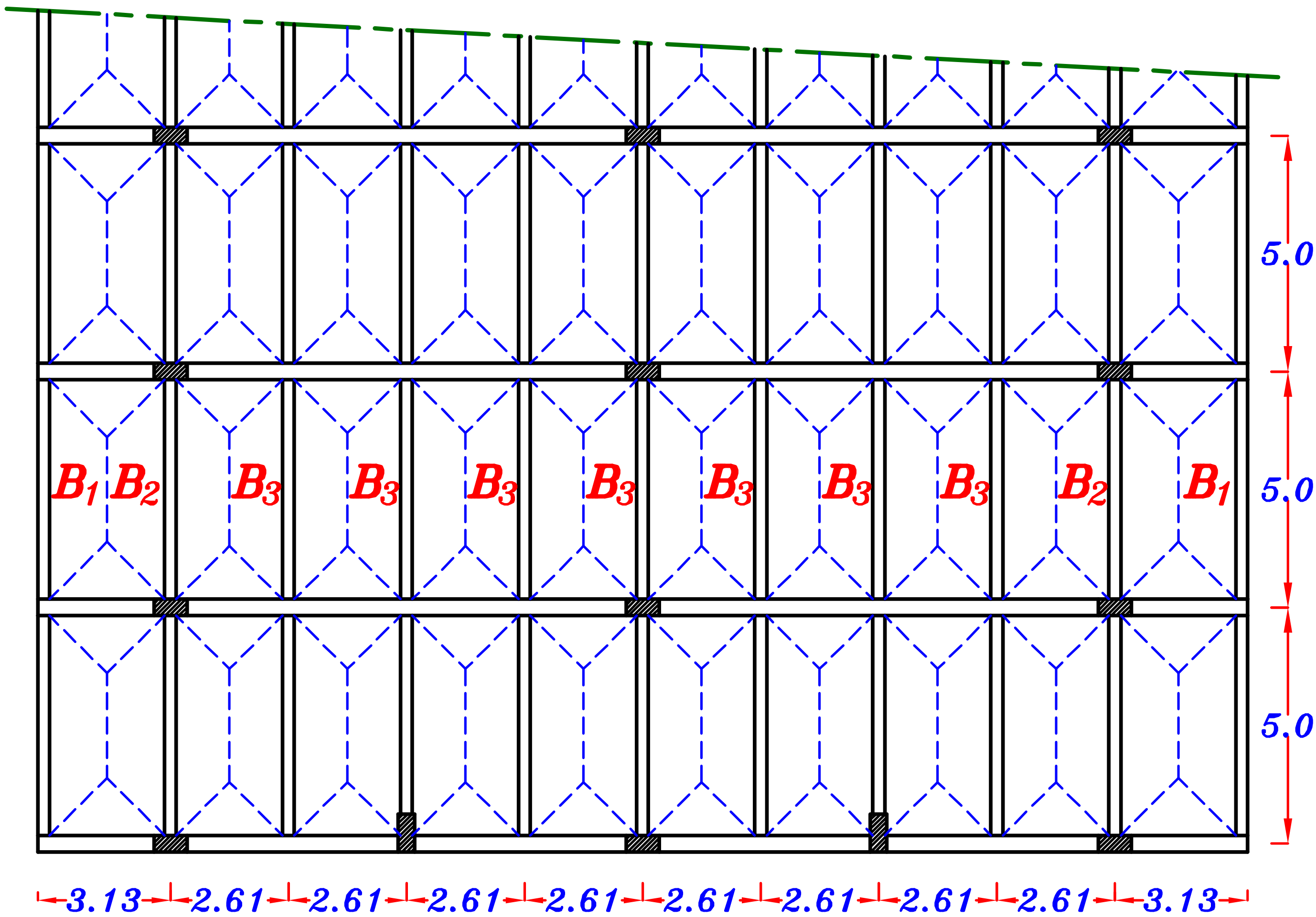
شريحه أفقيه فى بلاطة مائله ($M * Cos\ \theta$)



RFT. of the Slabs.



Loads on Beams.

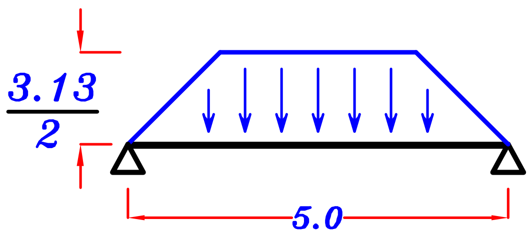


o.w. of Beams & Girder $= 1.4\, b\, t\, \gamma_c$

Beams (250 * 500) $\quad o.w. = 1.4\,(0.25)\,(0.5)\,(25) = 4.30\ kN\backslash m'$

Girder (300 * 800) $\quad o.w. = 1.4\,(0.30)\,(0.8)\,(25) = 8.40\ kN\backslash m'$

B_1



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.13}{5}\right) = 0.68$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.13}{5}\right)^2 = 0.87$$

$$w_a = O.W. + C_a\, w_{si}^{\text{trap}}\, \frac{L_s}{2} = 4.30 + 0.68\,(9.30)\left(\frac{3.13}{2}\right) = 14.2\ kN\backslash m'$$

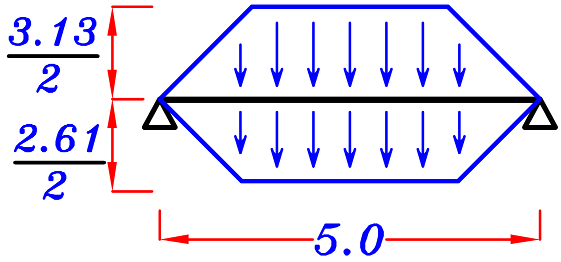
$$w_e = O.W. + C_e\, w_{si}^{\text{trap}}\, \frac{L_s}{2} = 4.30 + 0.87\,(9.30)\left(\frac{3.13}{2}\right) = 17.0\ kN\backslash m'$$

$$R_1 = w_a * Spacing = 14.2 * 5.0 = 71.0\ kN$$

$$\boxed{R_1 = 71.0\ kN}$$

B_2

Trapezoid ①



$$C_a = 1-\frac{1}{2}\left(\frac{L_s}{L}\right) = 1-\frac{1}{2}\left(\frac{3.13}{5}\right) = 0.68$$

$$C_e = 1-\frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1-\frac{1}{3}\left(\frac{3.13}{5}\right)^2 = 0.87$$

Trapezoid ②

$$C_a = 1-\frac{1}{2}\left(\frac{L_s}{L}\right) = 1-\frac{1}{2}\left(\frac{2.61}{5}\right) = 0.74$$

$$C_e = 1-\frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1-\frac{1}{3}\left(\frac{2.61}{5}\right)^2 = 0.91$$

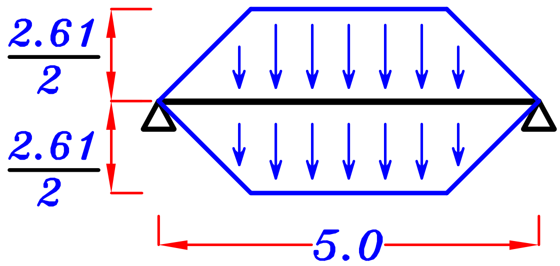
$$w_a = O.W. + C_a\, w_{si} \frac{L_s}{2} + C_a\, w_{si} \frac{L_s}{2} = 4.30 + 0.68\,(9.30)\left(\frac{3.13}{2}\right) + 0.74\,(9.30)\left(\frac{2.61}{2}\right) = 23.1 \text{ kN\m`}$$

$$w_e = O.W. + C_e\, w_{si} \frac{L_s}{2} + C_e\, w_{si} \frac{L_s}{2} = 4.30 + 0.87\,(9.30)\left(\frac{3.13}{2}\right) + 0.91\,(9.30)\left(\frac{2.61}{2}\right) = 28.0 \text{ kN\m`}$$

$$R_2 = w_a * \text{Spacing} = 23.1 * 5.0 = 115.5 \text{ kN}$$

$$\boxed{R_2 = 115.5 \text{ kN}}$$

B_3



$$C_a = 1-\frac{1}{2}\left(\frac{L_s}{L}\right) = 1-\frac{1}{2}\left(\frac{2.61}{5}\right) = 0.74$$

$$C_e = 1-\frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1-\frac{1}{3}\left(\frac{2.61}{5}\right)^2 = 0.91$$

$$w_a = O.W. + 2\, C_a\, w_{si} \frac{L_s}{2} = 4.30 + 2\,(0.74)(9.30)\left(\frac{2.61}{2}\right) = 22.2 \text{ kN\m`}$$

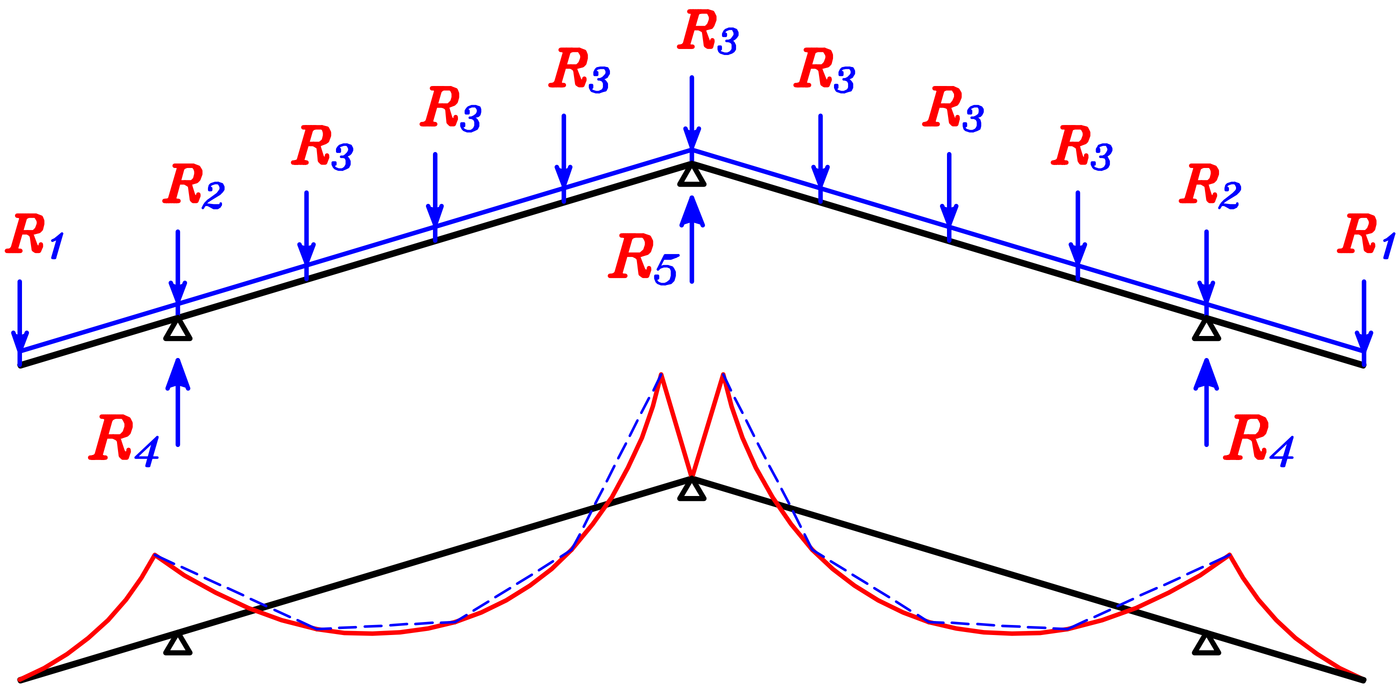
$$w_e = O.W. + 2\, C_e\, w_{si} \frac{L_s}{2} = 4.30 + 2\,(0.91)(9.30)\left(\frac{2.61}{2}\right) = 26.3 \text{ kN\m`}$$

$$R_3 = w_a * \text{Spacing} = 22.2 * 5.0 = 111 \text{ kN}$$

$$\boxed{R_3 = 111 \text{ kN}}$$

Girders

Desined on M

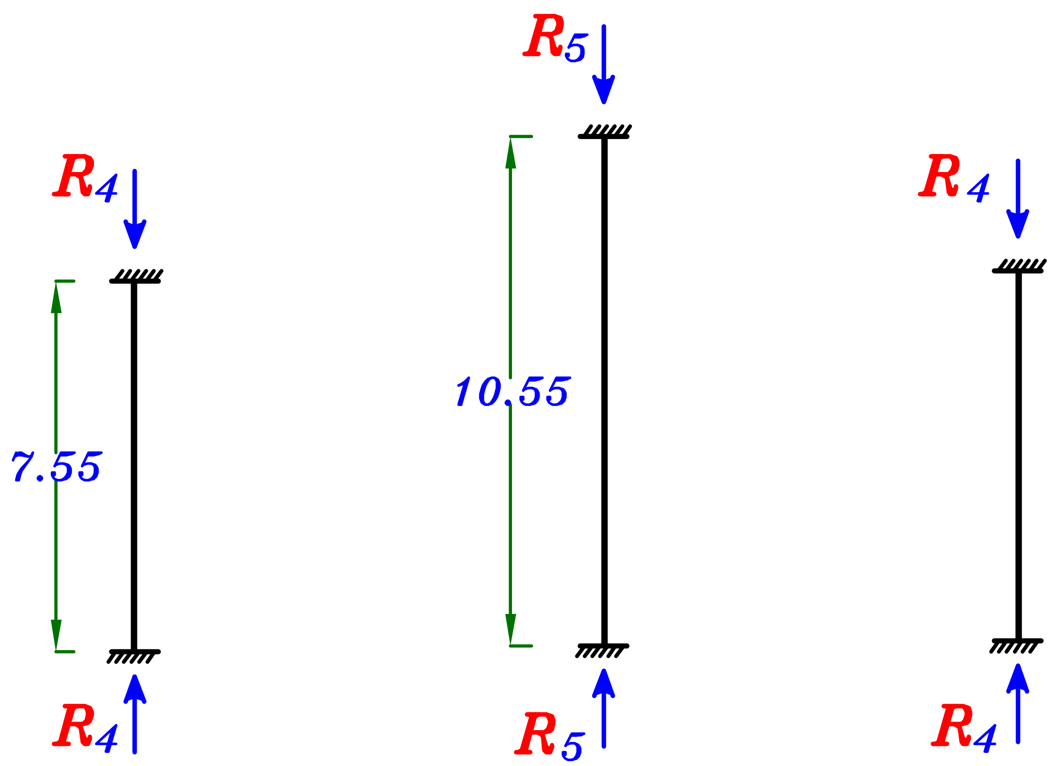


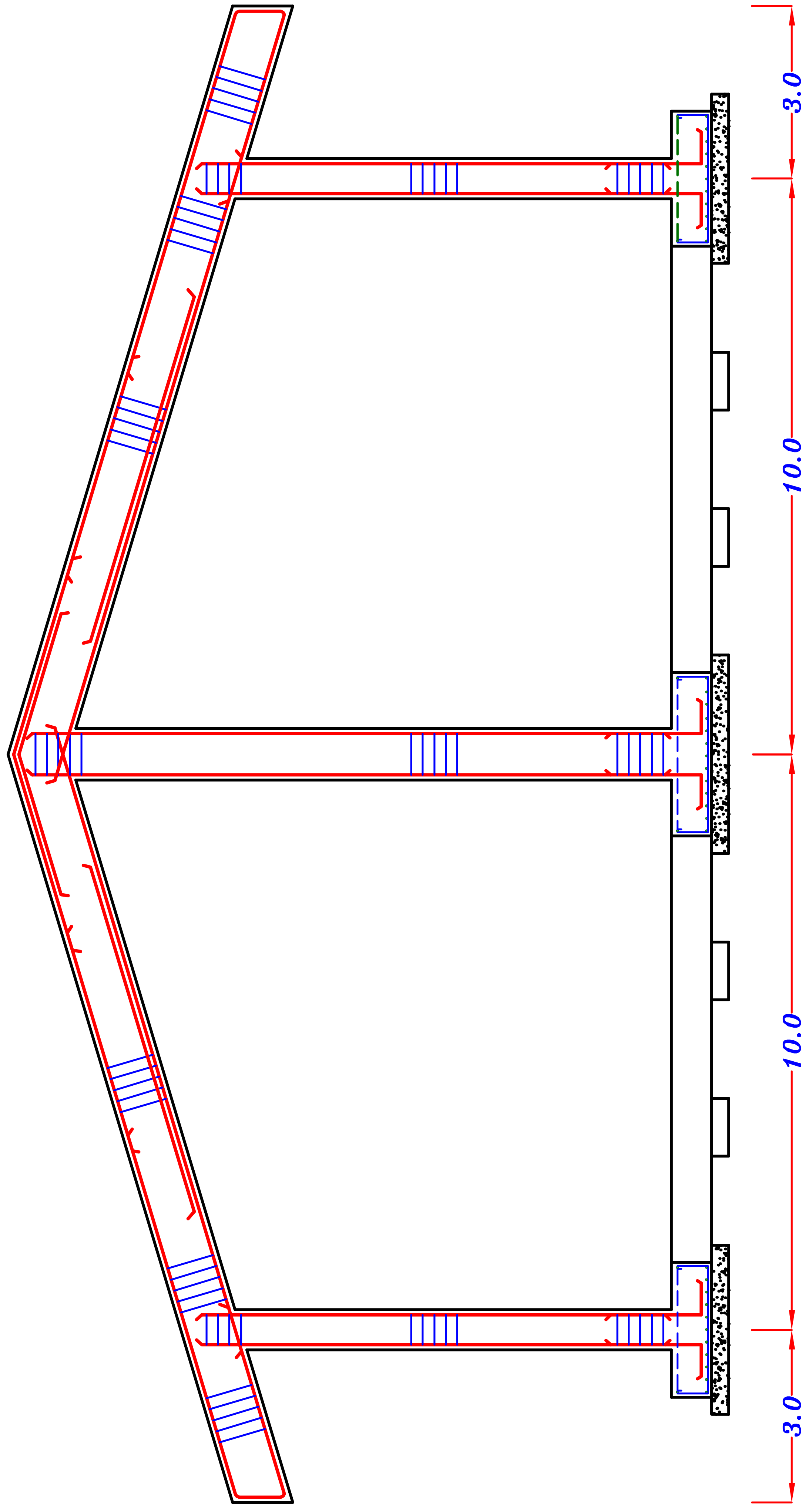
Solved by 3 Moment eqn.

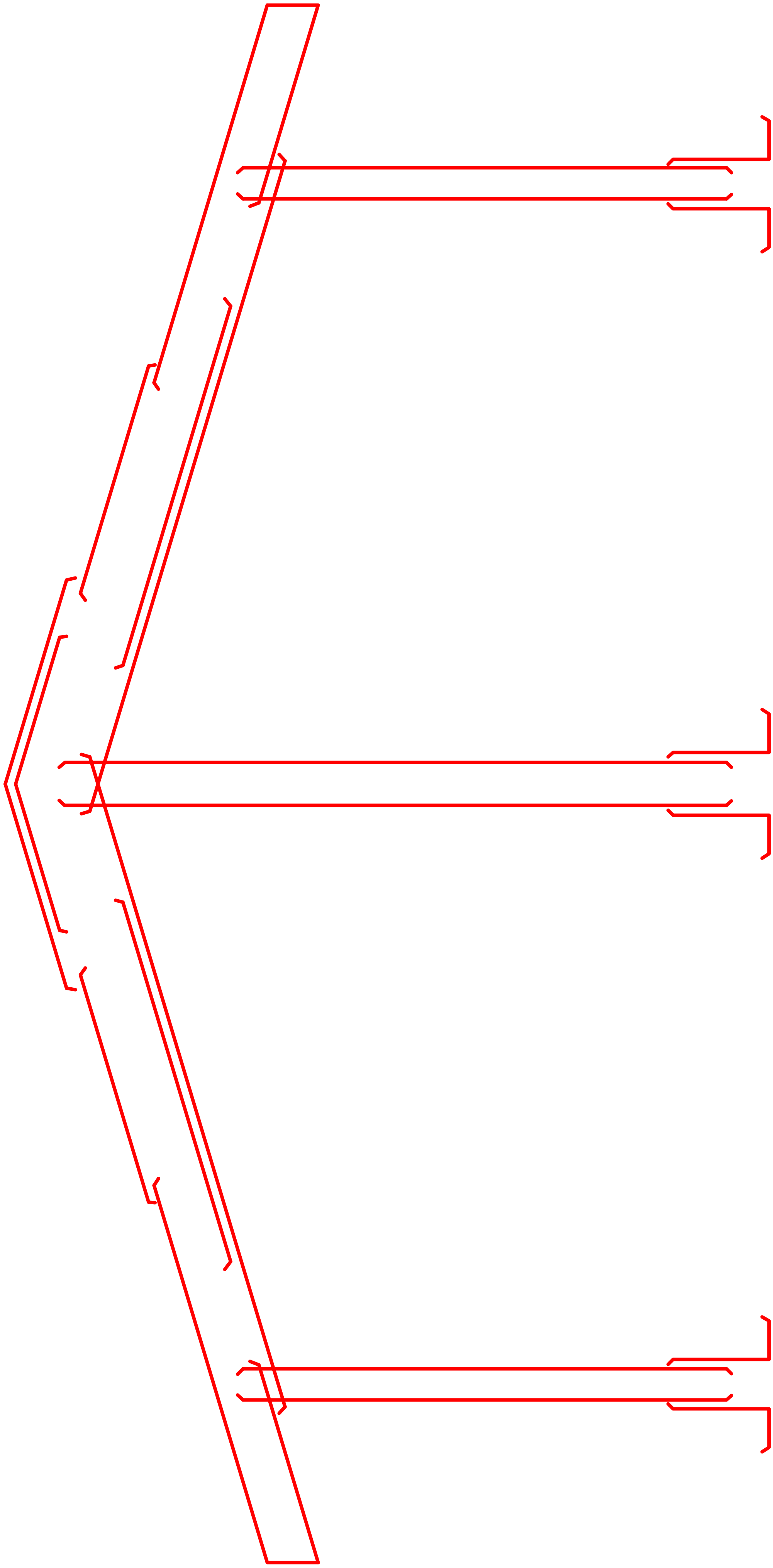
Columns

Check Buckling

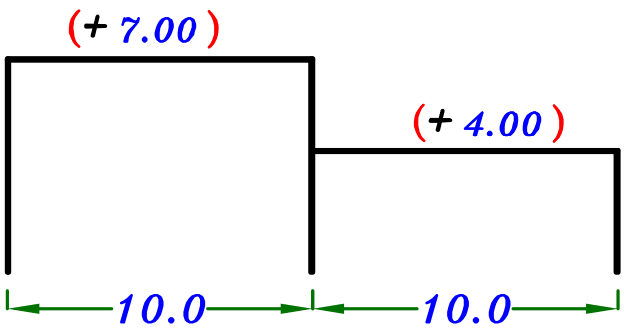
and Designed on P, M_{add}



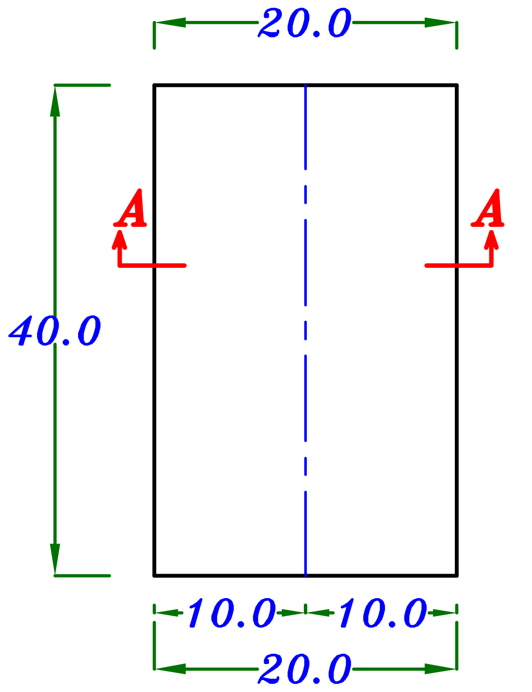

3.0
10.0
10.0
3.0



Example.

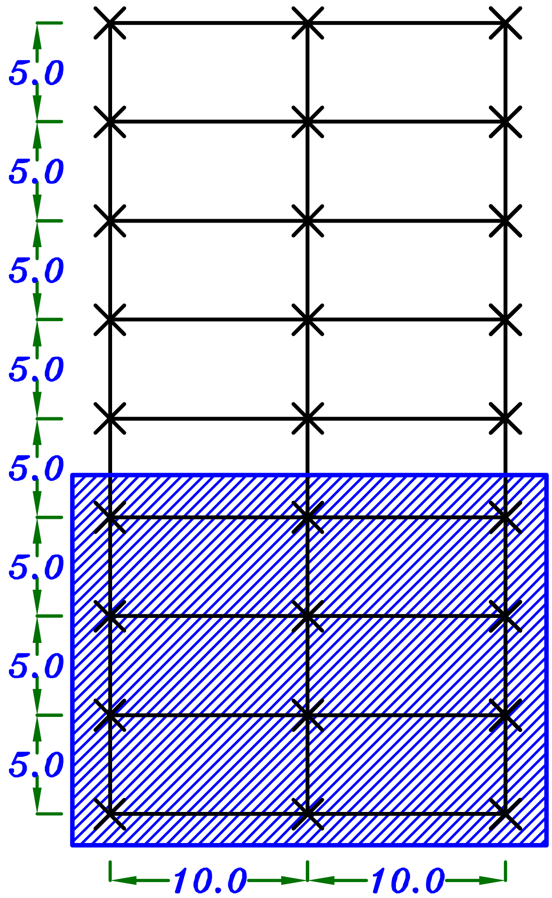


Sec. A–A



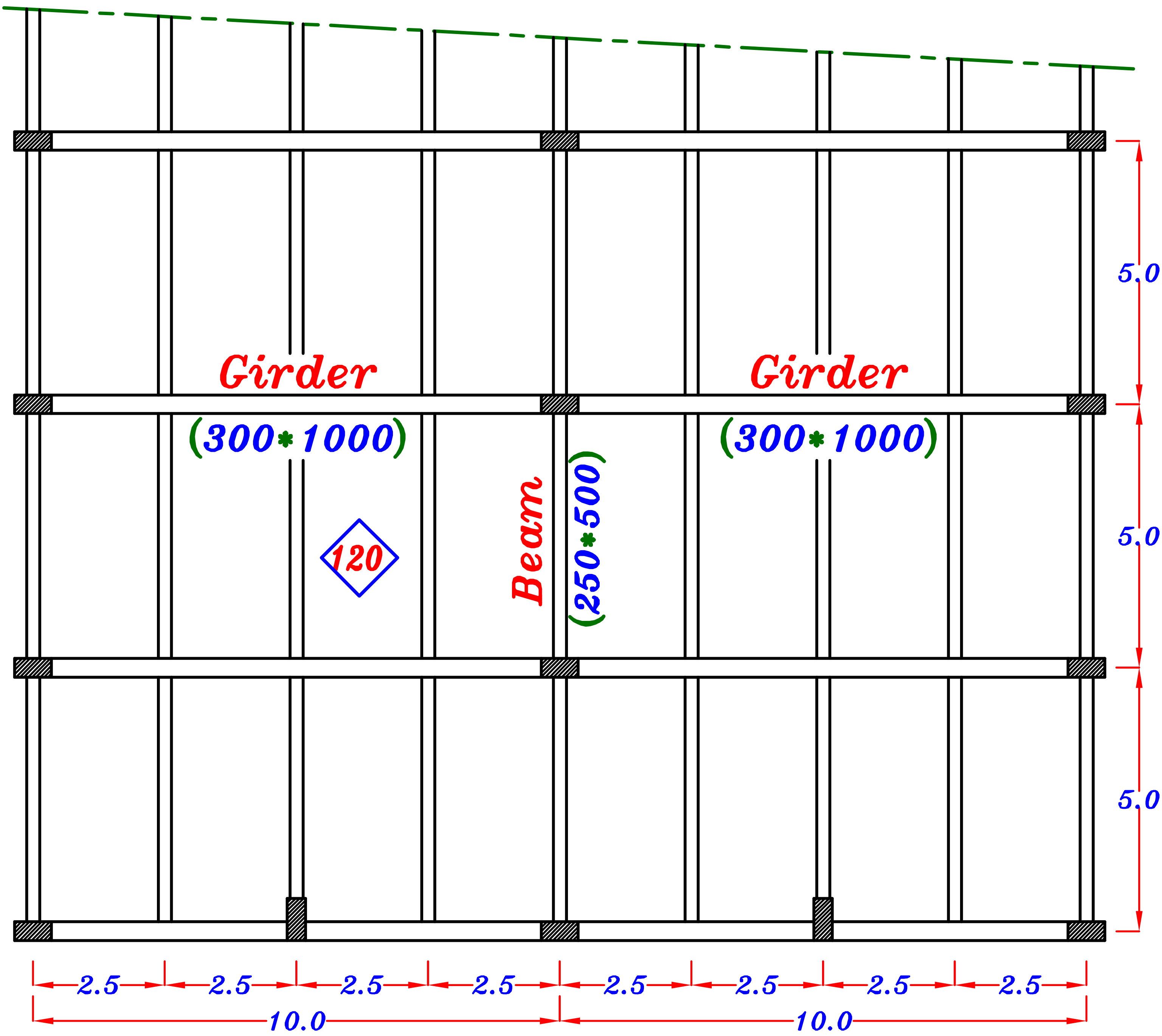
Req.

1 – Draw concrete Dimensions in plan & elevation.
2 – Draw RFT. of slabs in plan.

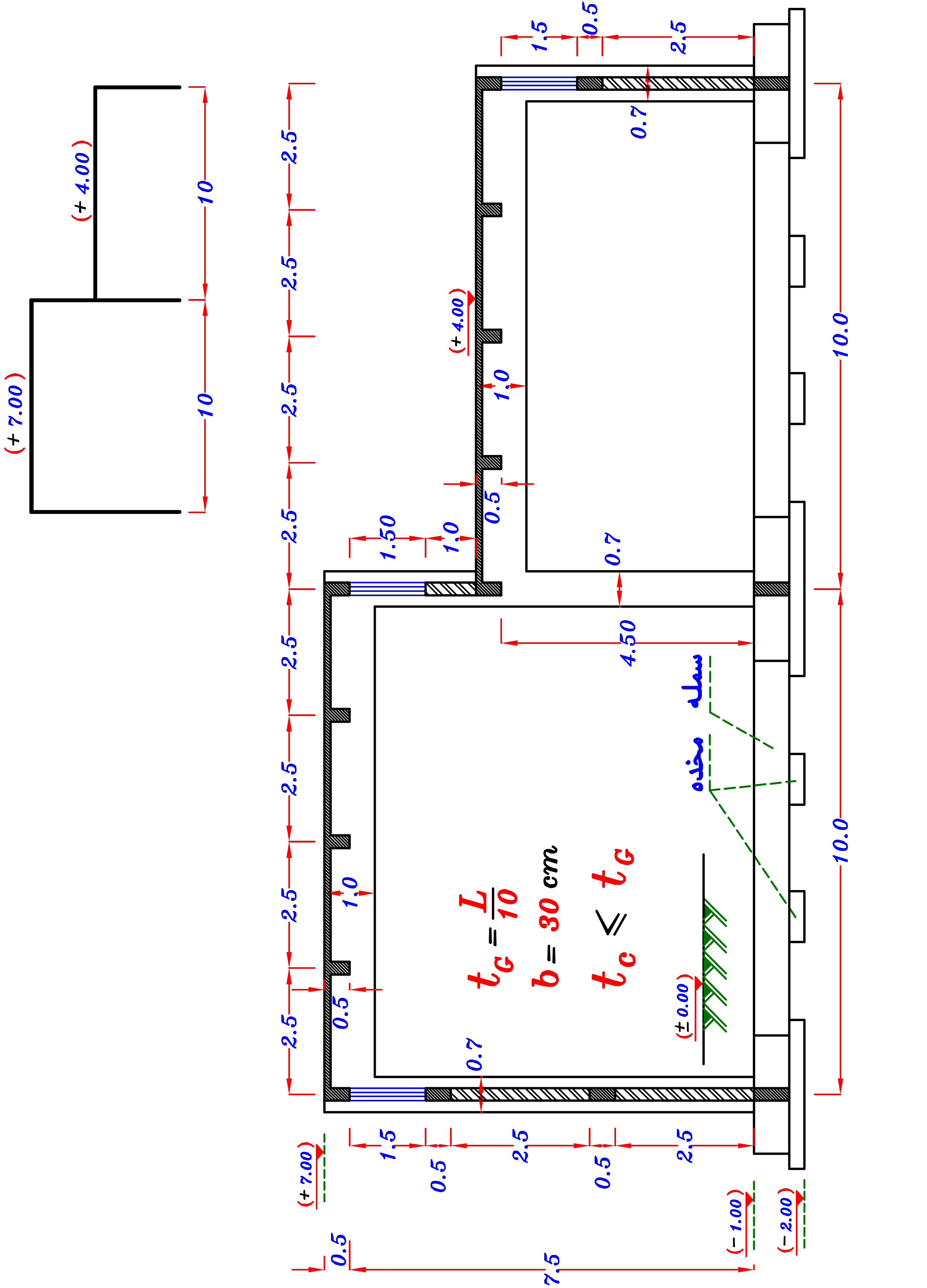


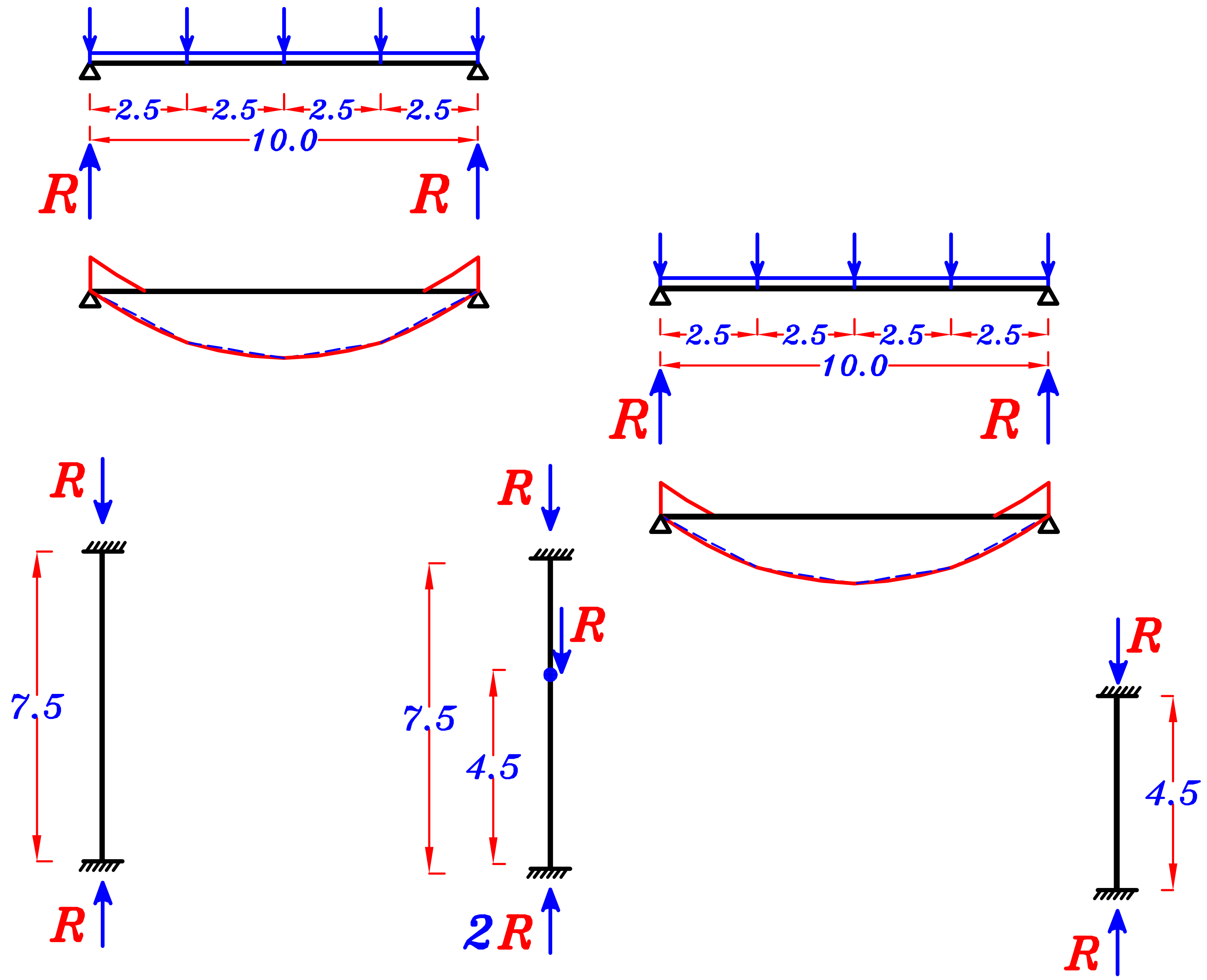
Key Plan

Plan concrete Dimensions.



Plan


(+ 7.00)
(+ 4.00)
10
10
2.5
1.5
0.5
0.7
1.0
1.50
4.50
10.0
7.5
(± 0.00)
(− 1.00)
(− 2.00)
سملة
مخده
$t_G = \frac{L}{10}$
$b = 30\ cm$
$t_c \leqslant t_G$

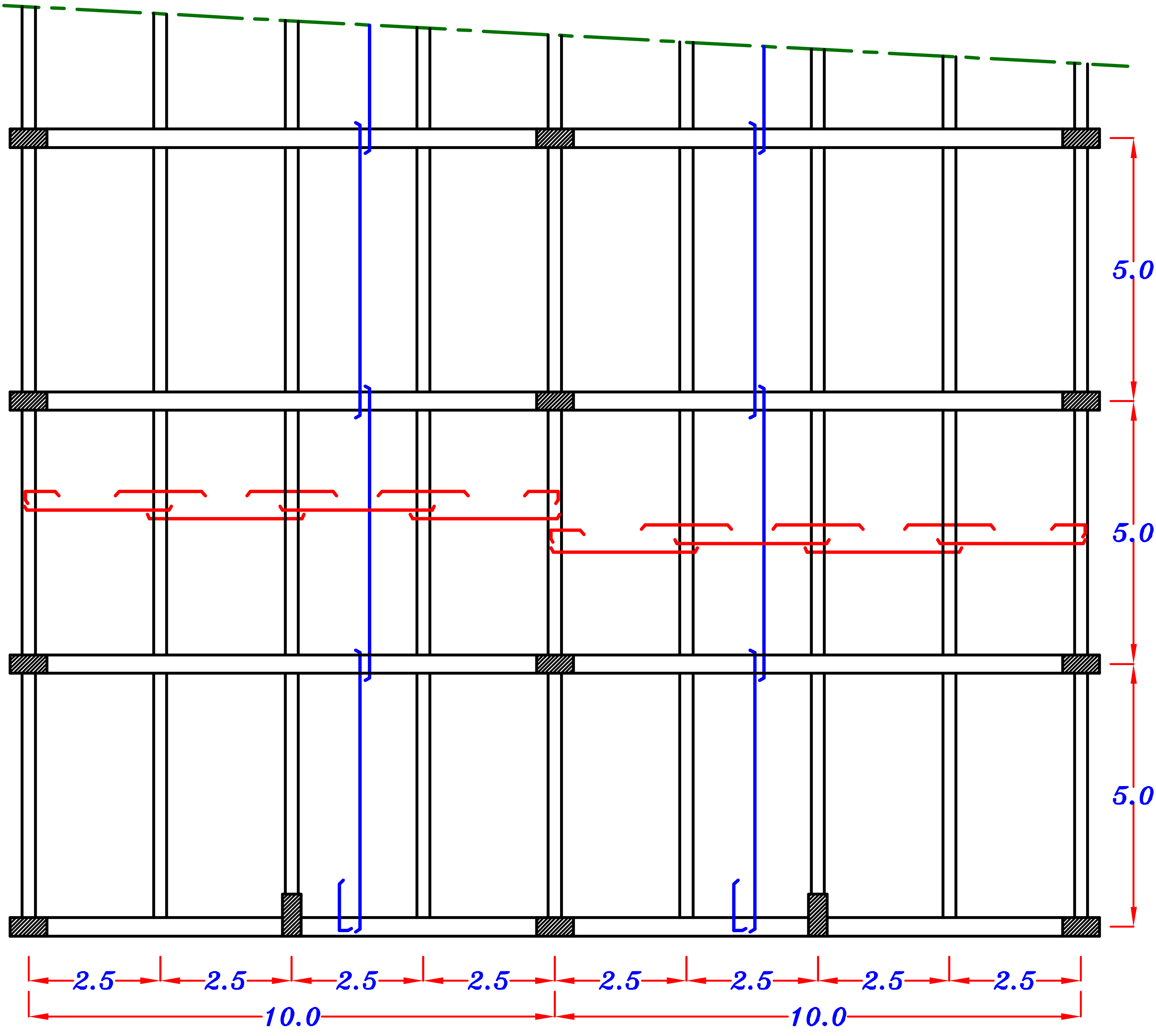


Columns

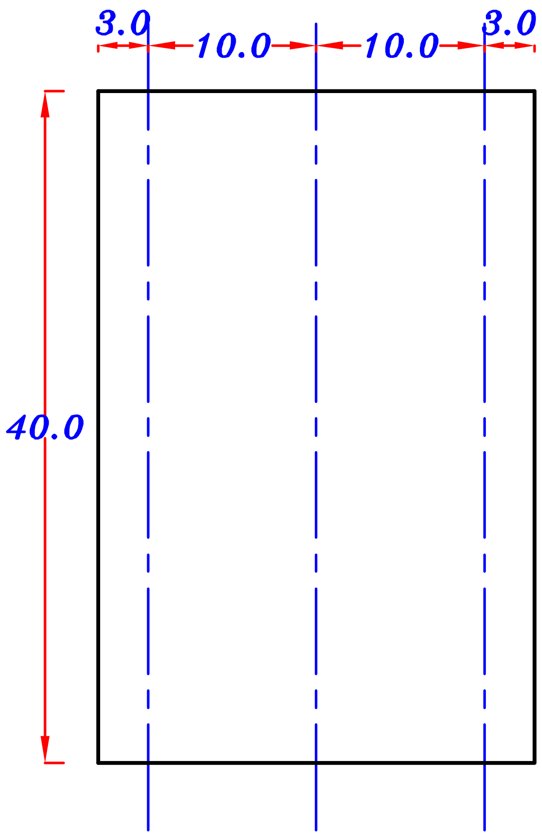
Check Buckling

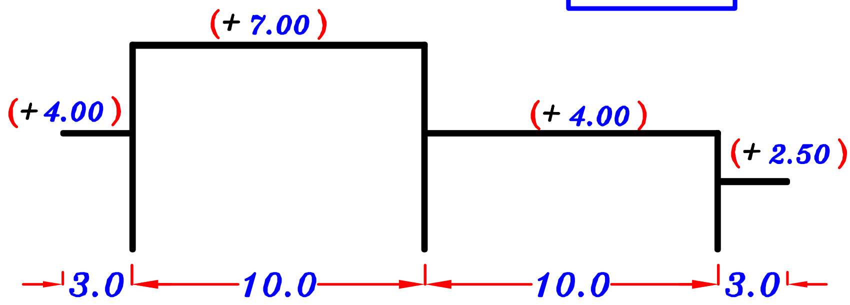
and Designed on P, M_{add}

RFT. of the Slabs.



Example.

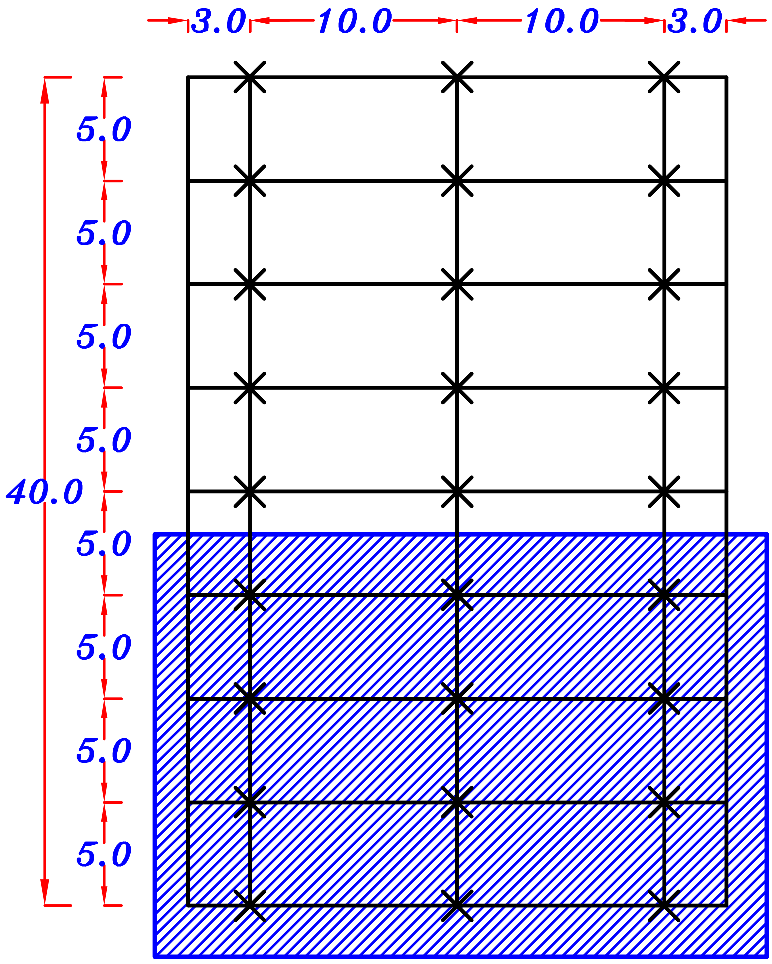




Req.

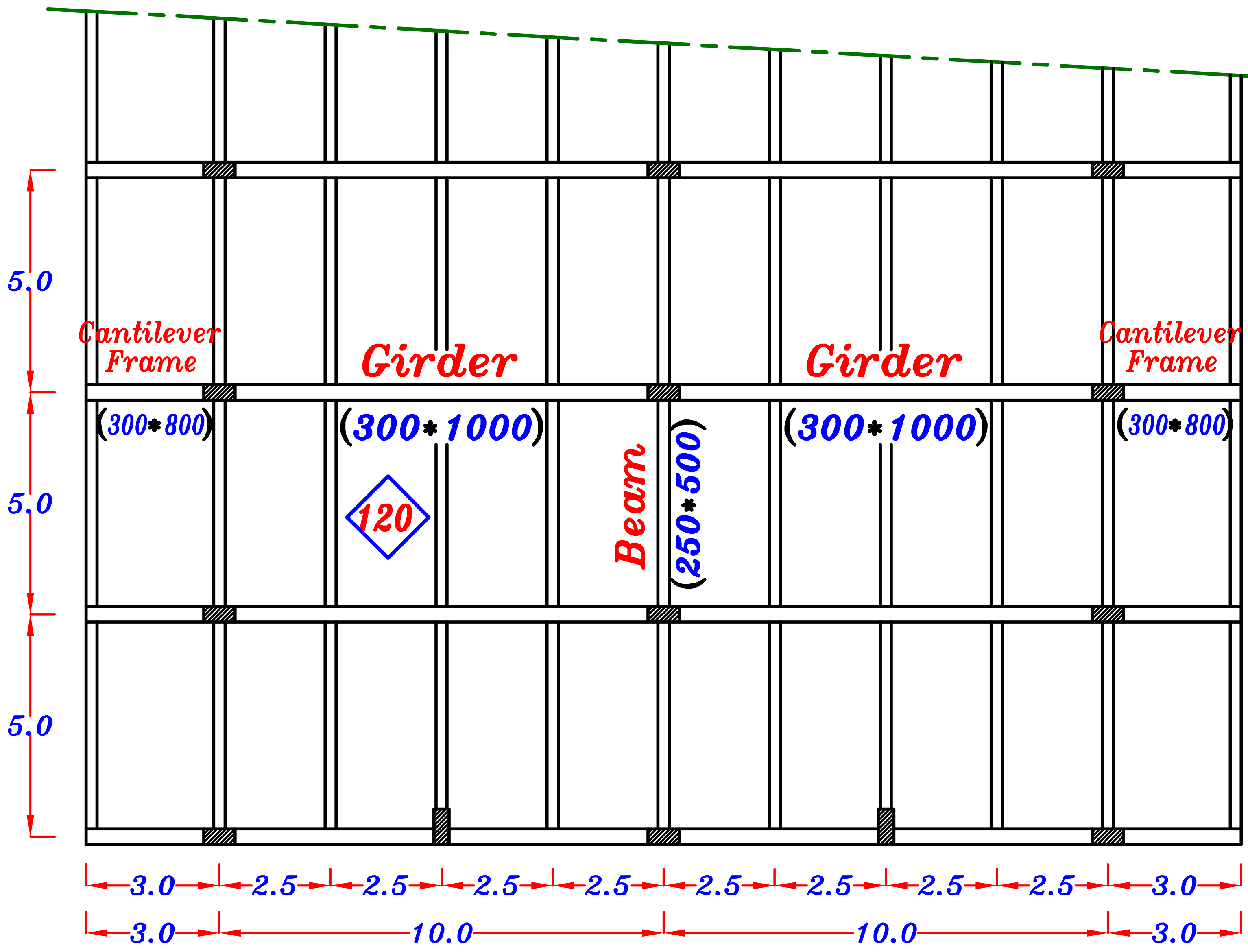
1 – Draw concrete Dimensions in plan & elevation.

2 – Draw RFT. of slabs in plan.

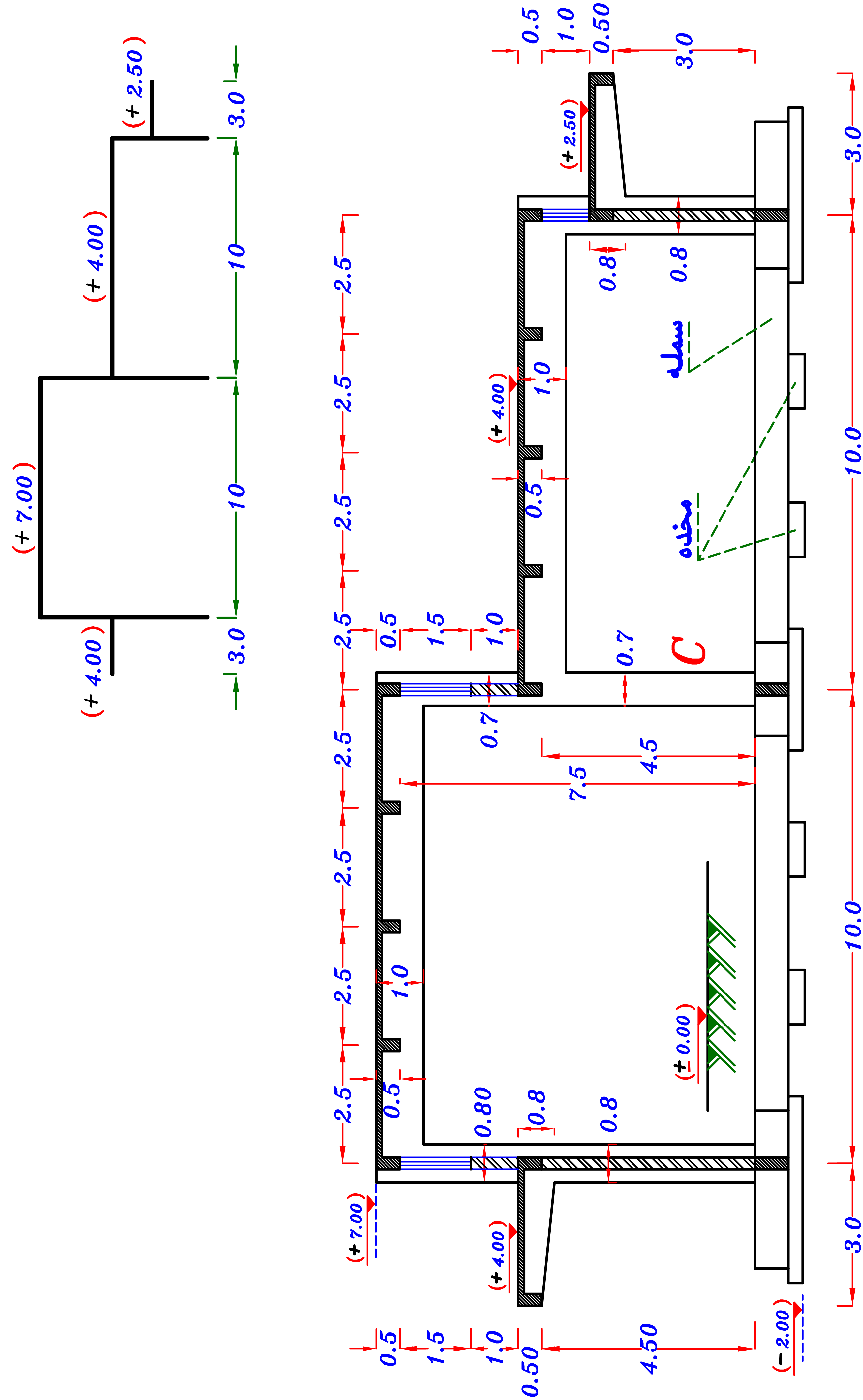


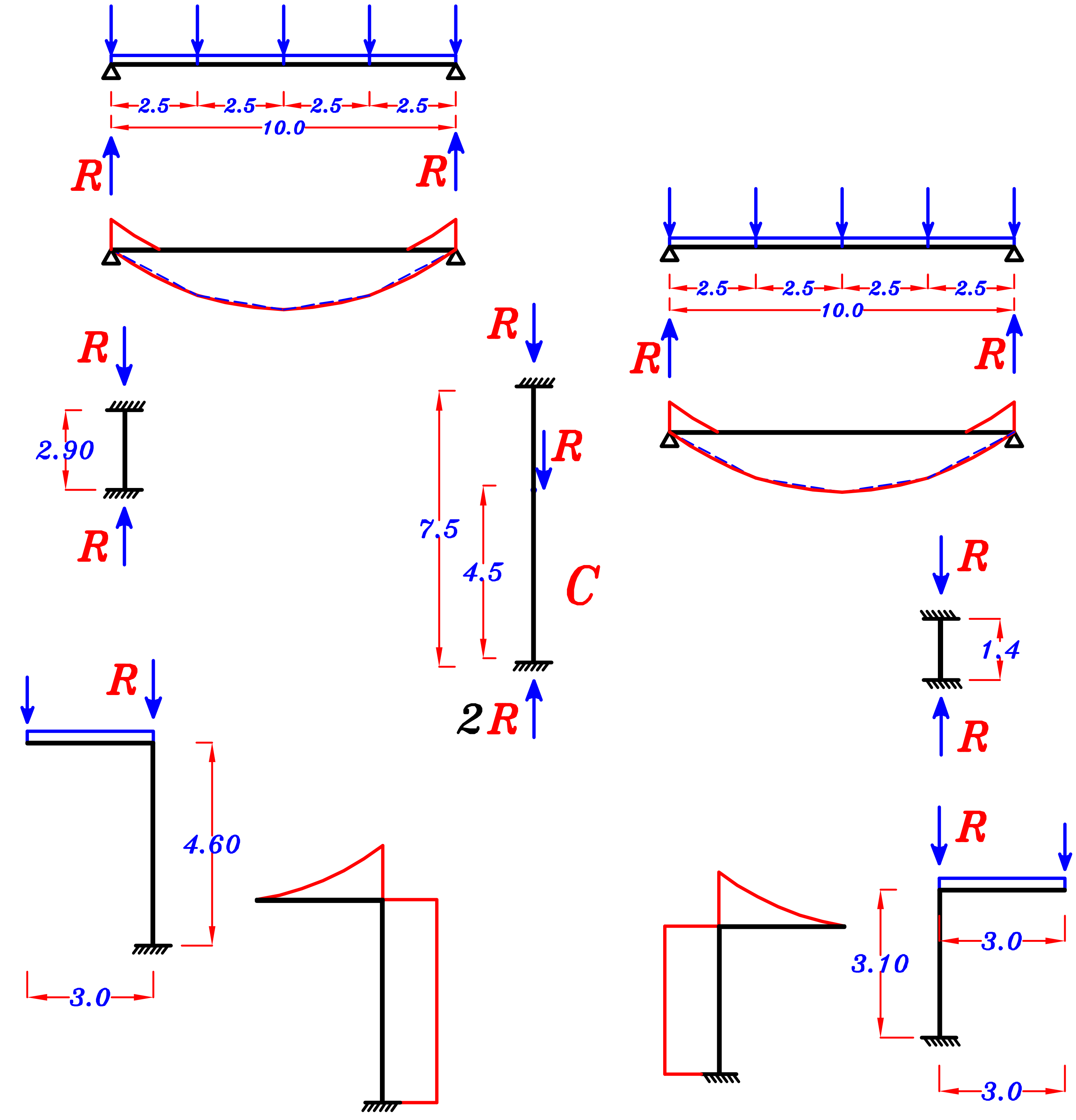
Key Plan

Plan concrete Dimensions.



Paln


(+ 7.00)
(+ 4.00)
(+ 2.50)
(± 0.00)
(− 2.00)
C
مخده



Girders

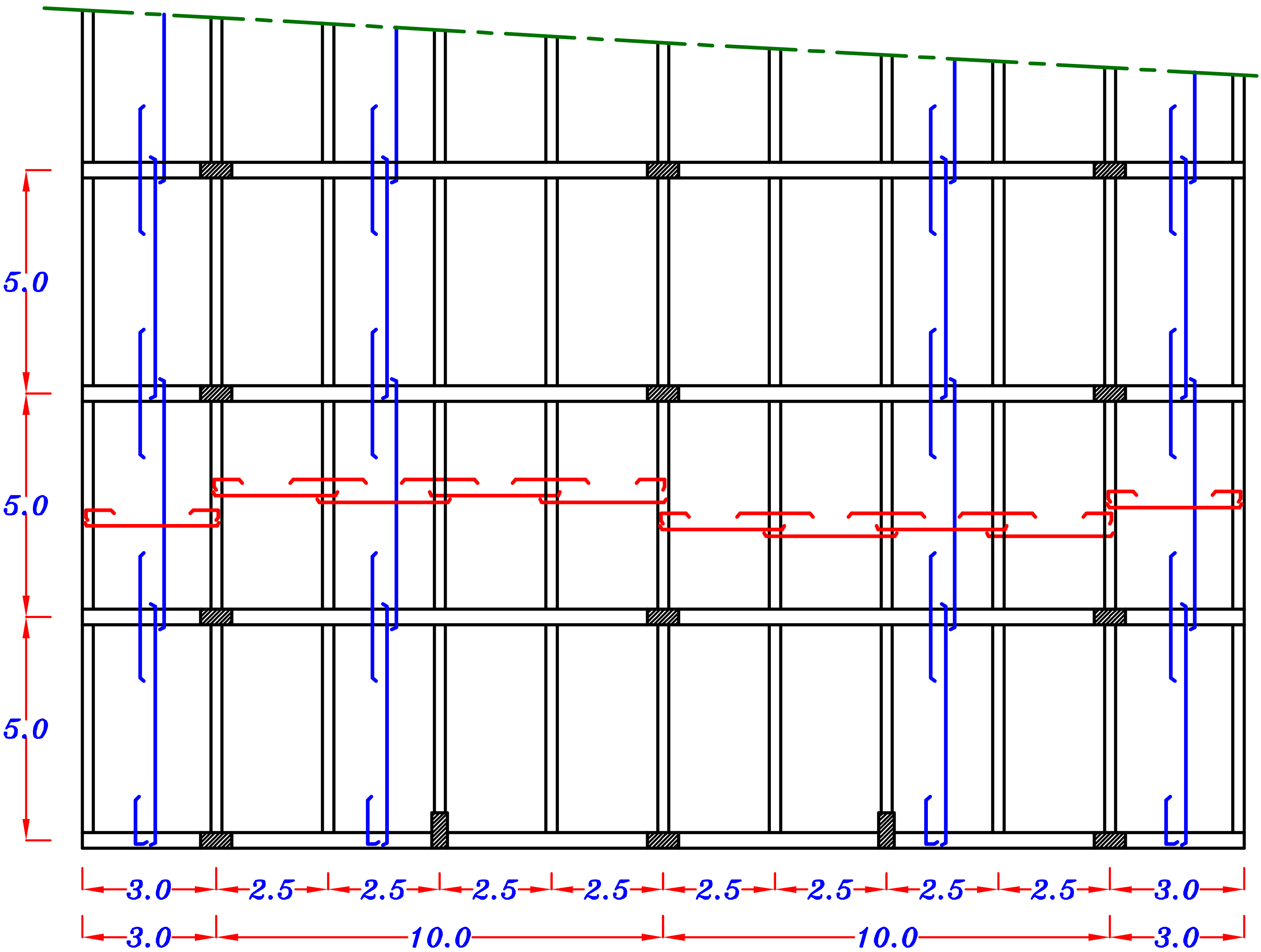
Desined on M

Column C

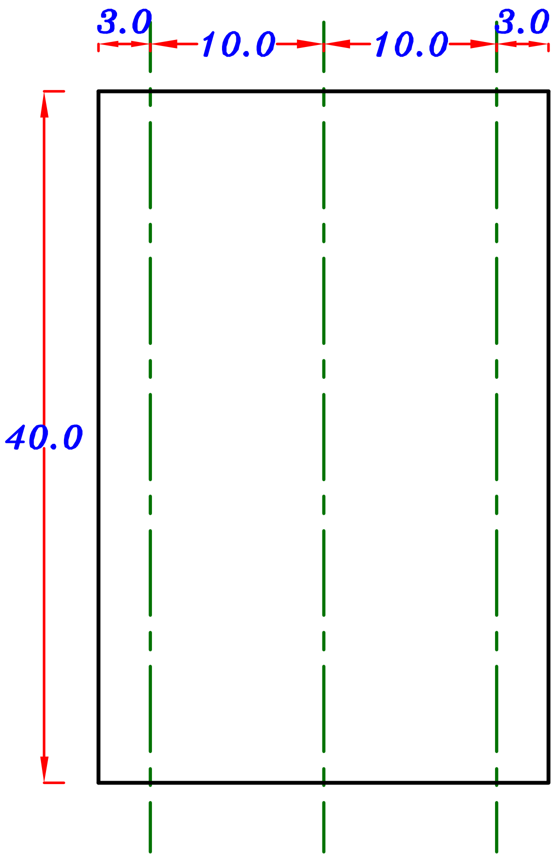
Check Buckling

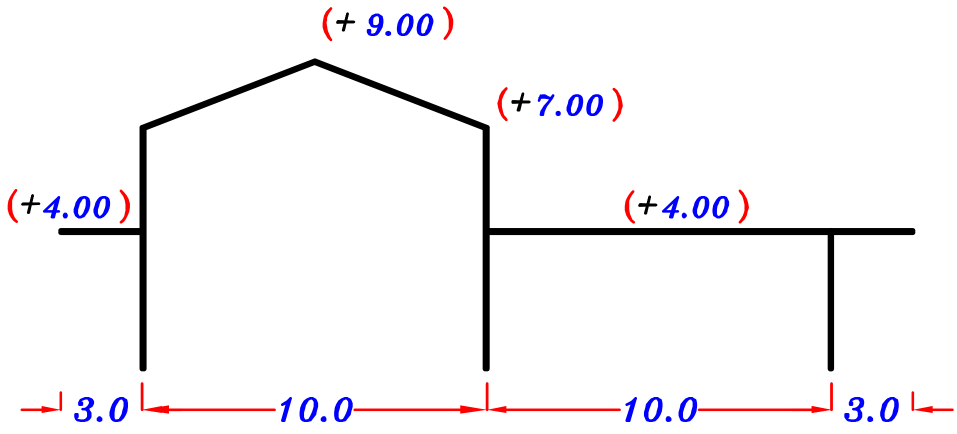
and Desined on P, M_{add}

RFT. of the Slabs.



Example.

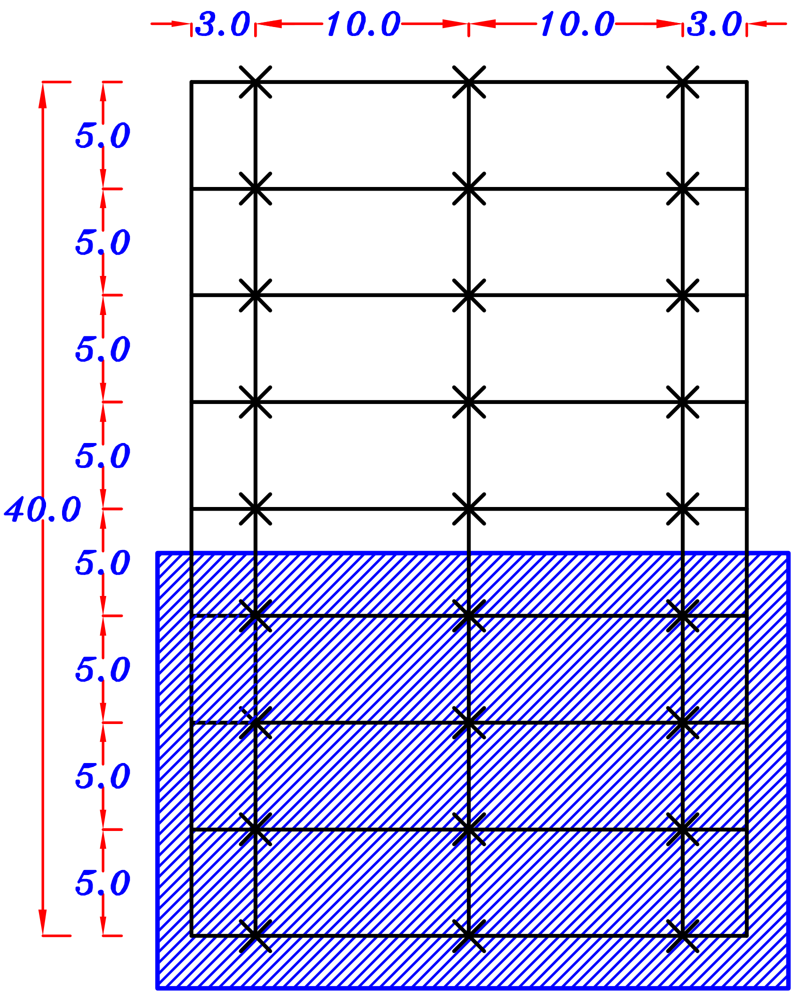




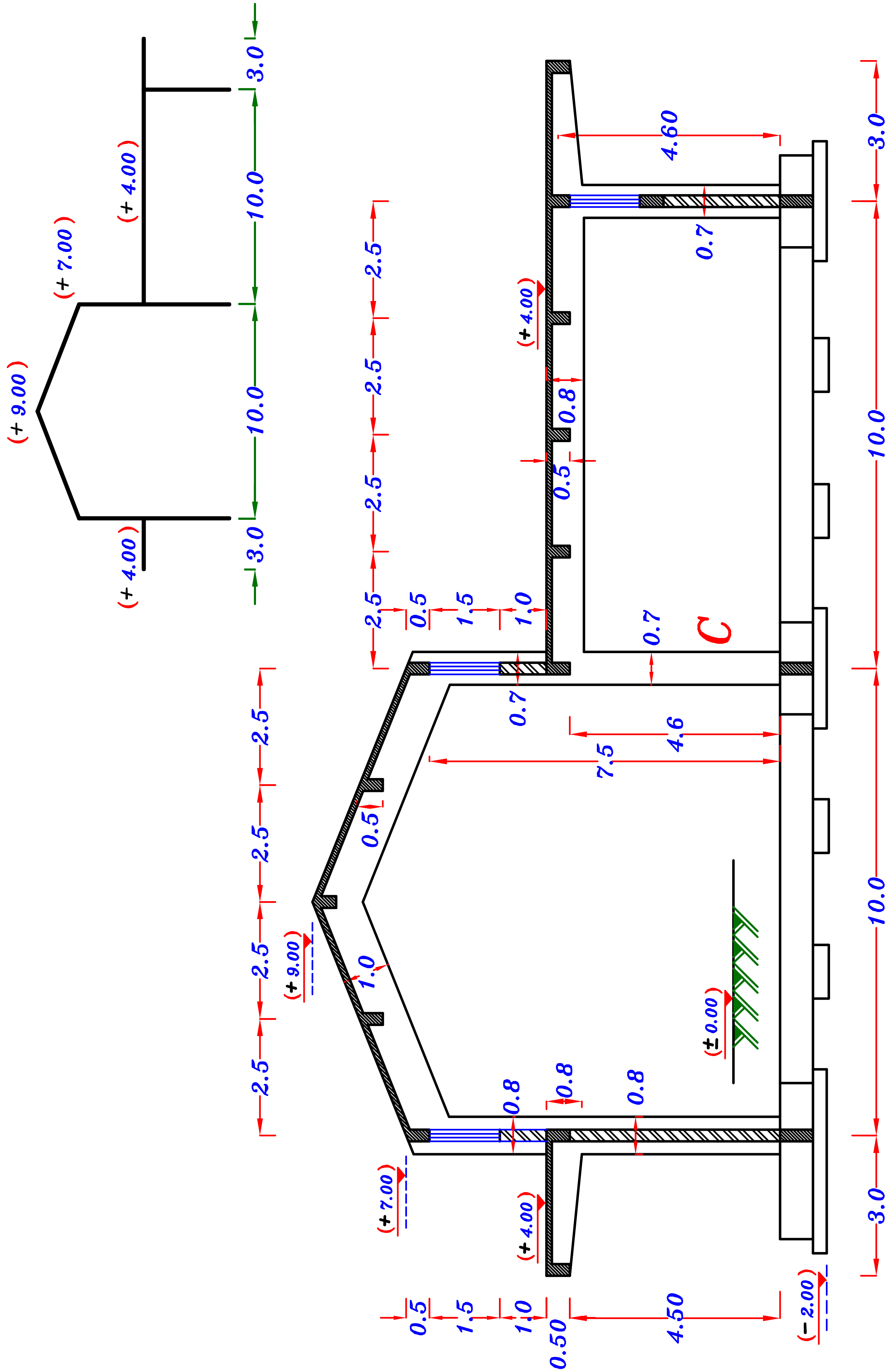
Req.

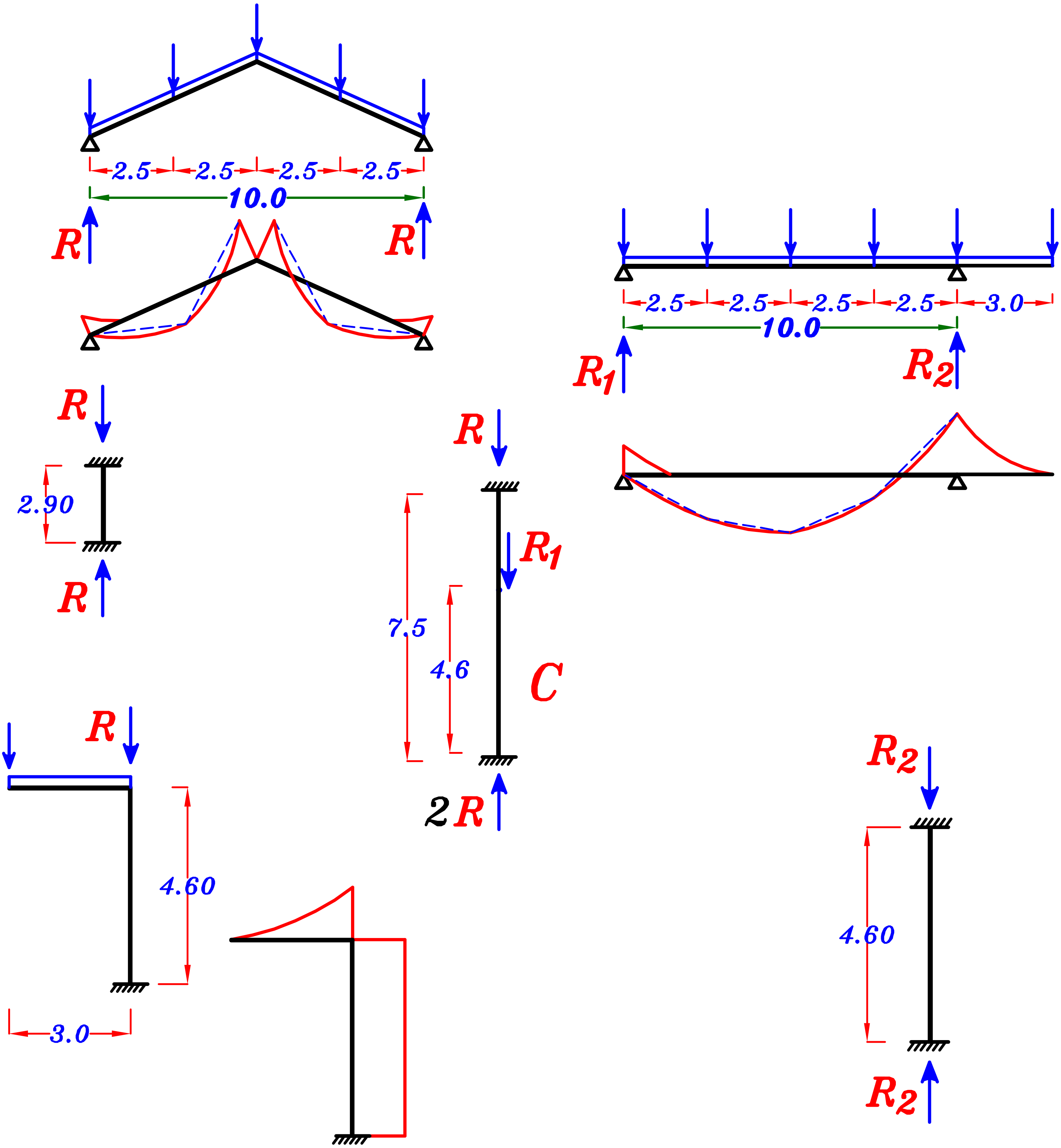
1 – Draw concrete Dimensions in plan & elevation.

2 – Draw RFT. of slabs in plan.



Plan


(+ 9.00)
(+ 7.00)
(+ 4.00)
(± 0.00)
(− 2.00)
C
3.0
10.0
2.5
4.60
4.6
7.5
0.7
0.8
0.5
1.5
1.0
4.50
0.50



Girders

Designed on M

Columns

Check Buckling

and Designed on P, M_{add}

RFT. of the Slabs.